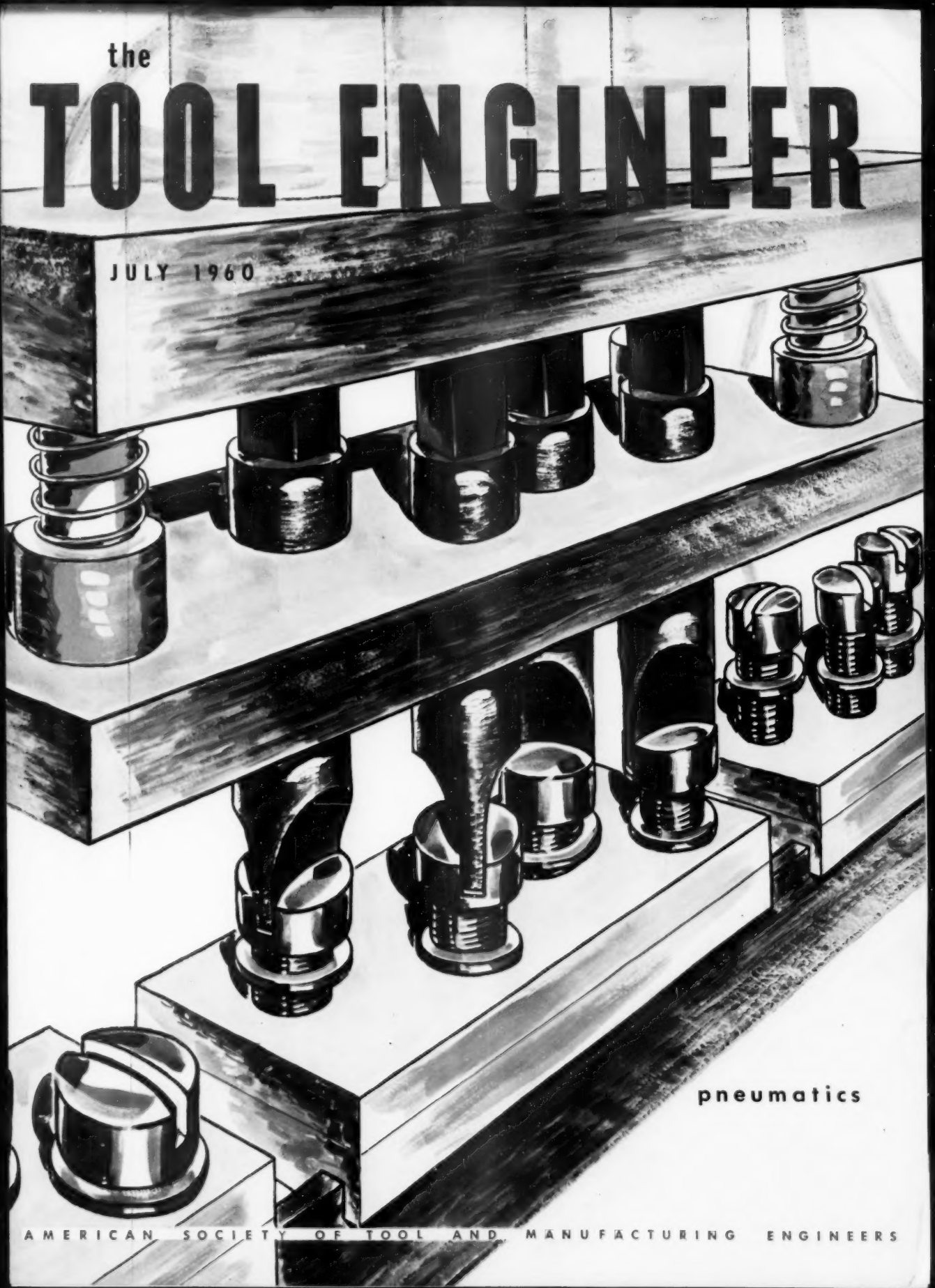
the

TOOL ENGINEER

JULY 1960



pneumatics

AMERICAN SOCIETY OF TOOL AND MANUFACTURING ENGINEERS

30" HEALD ROTARY

surface grinds

rotary index tables

with

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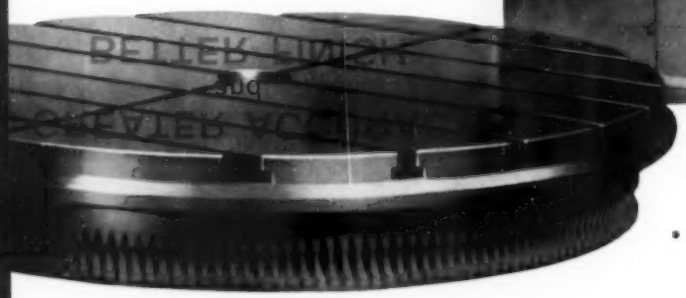
and
BETTER FINISH



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ON this Heald Model 361 30" Plain Rotary Surface Grinder, rotary indexing tables for other high-precision machine tools are ground flat and parallel within .0002", and to a surface finish of 15 micro-inches or better. Cast iron tables from 10 to 30 inches in diameter are easily handled, as well as a variety of miscellaneous parts.

Although high production was not a requirement, this Rotary enabled parts to be finished up to *five times faster* while obtaining greater accuracy and better finish than could be obtained with previous methods.

An adjustable wheel dresser built into the wheel-guard permits truing the wheel without resetting the wheelslide or moving the table. And a demagnetizing switch facilitates setup and unloading.

Heald offers a complete line of high-precision rotary surface grinding machines with chuck sizes from 6 to 30 inches and either manual or automatic reciprocation. Ask your Heald engineer for complete details, or send for a copy of Bulletin 2-361-1 Issue 2.

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HEALD

the tool engineer

Vol. 45, No. 1
July 1960

Creative Manufacturing is TOOL ENGINEERING

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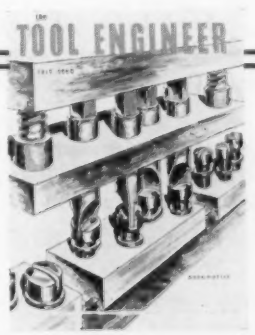
THIS MONTH'S COVER

Pneumatic power is used by tool and manufacturing engineers in a variety of ways. This cover shows a pneumatically actuated automatic assembly device for tightening down nuts. Torque is preset, preventing damage to tool or workpiece caused by excessive tightening. Other applications of pneumatic power are discussed in the article beginning on page 50.



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Sun is literally a supermarket for soluble oils—all the way from a low-cost emulsifying oil to a chemical coolant. Each one can solve a different production problem. For example:

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Building for the Future

Confidence in the future results from careful planning and a firm belief in the benefits of research and development. Without these essential ingredients of industry, progress could not develop sufficiently fast to maintain our economic position. Organized research is the responsible way in which new products can be developed at a desired rate and for which there is a need to assure a sufficient market.

In a dynamic economy, such as ours, these new and better products are essential to maintain our standard of living. We have become accustomed to expect and accept luxuries of living that are possible only through increasing productivity and the ability to manufacture products for both domestic and foreign markets.

When the fruits of research result in products used in the production of other products the benefits of progress can be compounded, i.e., the original manufacturer profits and the user in turn profits through better and more economical manufacture. In fact, in our system, the seller and buyer must each profit or one or the other would soon fail in his enterprise.

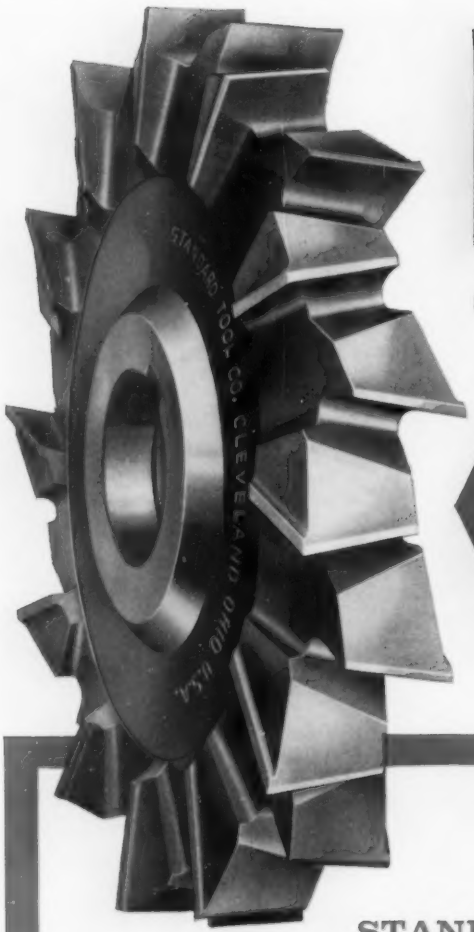
An excellent example of a company that believes in progress through research and that practices what it preaches is the Warner & Swasey Co. in Cleveland. Over the years, it has consistently and increasingly appropriated funds for R&D. In keeping with this program, Warner & Swasey has built a new research center in the suburban area of Cleveland. This center is dedicated to the theme "Building for the Future" and, as stated by President Walter K. Bailey, brings together all R&D activities and personnel of the company for greater efficiency and economy.

A review of the recent achievements of Warner & Swasey and a look at the company's new lathe features and automatic controls are testimony to its enlightened program. With production equipment of this caliber, the tool and manufacturing engineer can improve his facilities and in turn make a better product for his customer. That is the fiber of which our economy is made.

John W Greve

EDITOR

balanced



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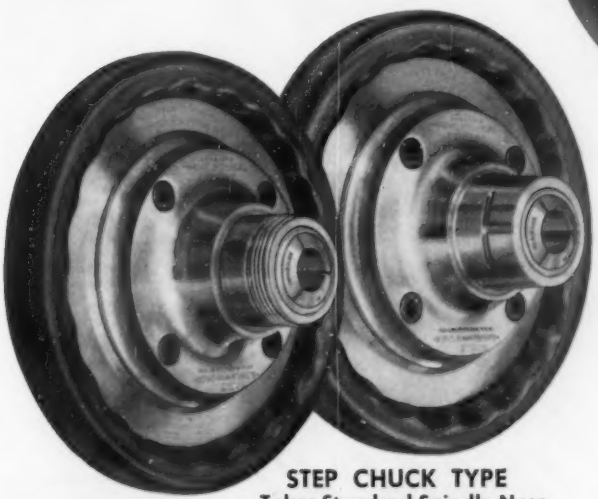

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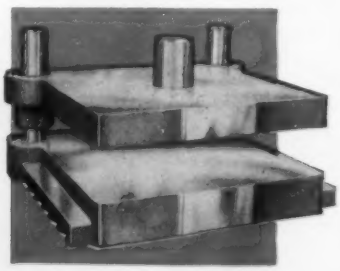

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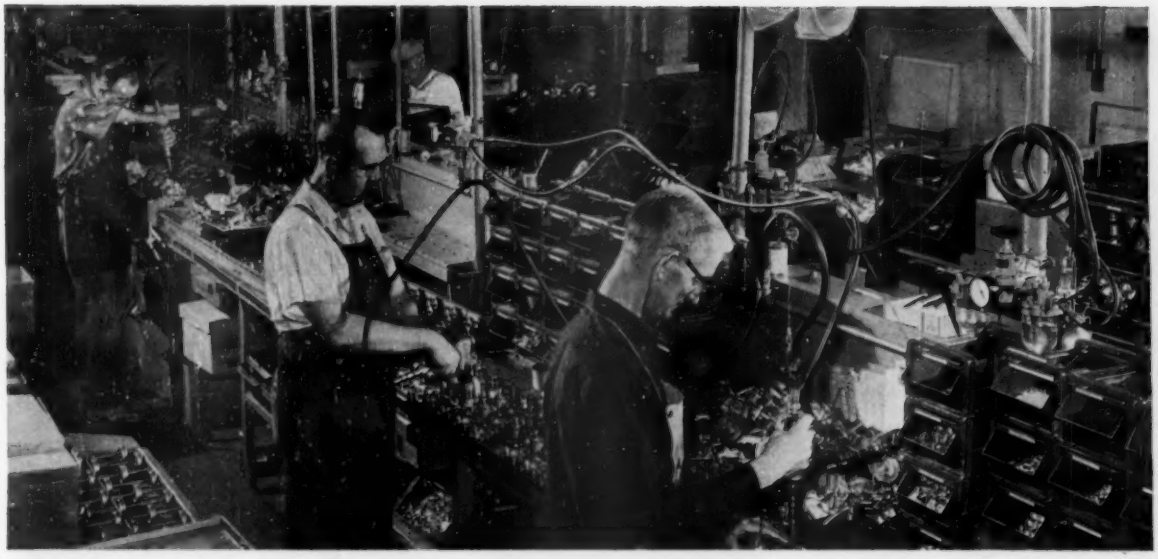


How to increase the life of your air tools and cylinders

...Norgren Lubro-Control Units reduce wear, improve equipment performance and cut maintenance costs.

To get maximum life from your air tools and other pneumatic devices, it is essential to filter the compressed air, control its pressure and to provide proper lubrication.

Filter removes abrasive solids and corrosive liquids

Compressed air as it comes directly from an air line generally carries with it dirt, pipe scale, rust and various liquids. If these substances are allowed to be carried by the air into your air tools, cylinders and other air-operated equipment, they will cause excessive wear and corrosion. The operating life of your air-devices will be cut short, and maintenance costs will be high. An air line filter must be used to remove these abrasive solids and corrosive liquids from the compressed air.

Regulator controls pressure

The fluctuating pressure of your compressed air system should be controlled by a pressure regulator. The regulator holds the pressure constant at the working pressure at which the pneumatic equipment will operate most efficiently.

Micro-Fog Lubrication ideal for air-equipment

Finally—and most important—pneumatic equipment must be given the right amount of lubrication. The best way to provide this lubrication is to put a lubricant into the air stream that powers the equipment.

A Micro-Fog Lubricator injects a fog of extremely fine particles of oil automatically and continuously into the air stream. It can be adjusted to meter just the right amount of oil for proper lubrication.

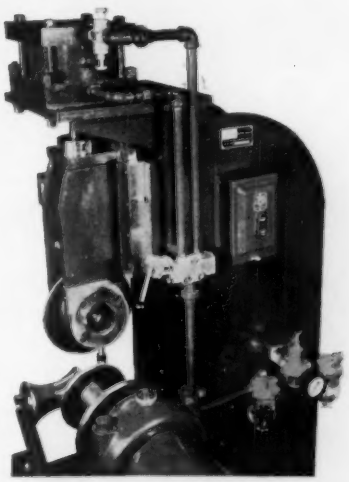
Micro-Fog particles are extremely fine. When injected into the air stream, they are like dry smoke until they reach the point to be lubricated. Because of this, Micro-Fog can be conveyed long distances and through complex piping systems without condensing into larger oil particles in the air line.

Norgren Lubro-Control Unit:

This unit consists of:

1. An air line filter.
2. A pressure regulator.
3. A Micro-Fog Lubricator.

It gives you these important benefits: better equipment performance, less wear, longer service life, less down time, lower maintenance costs.



The Norgren Lubro-Control Unit on this pipe cutting machine keeps the air cylinders operating at top efficiency. Without the Norgren unit, it was found virtually impossible to get the close control that is vital to the operation of the machine.

FOR COMPLETE INFORMATION, **call your nearby Norgren Representative, listed in your telephone directory — or WRITE FOR DESCRIPTIVE LITERATURE.**

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Meets JIC Standards, Bulletin 101A

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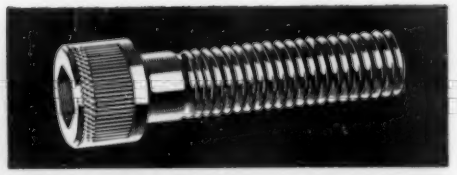
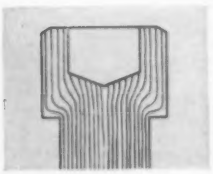
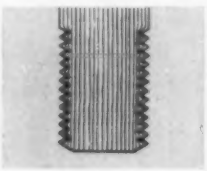
HOW THE NEW UNBRAKO CAP SCREW GOT ITS EXTRAORDINARY STRENGTH



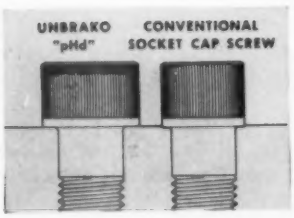
Sometimes "how it got that way" gives a good idea of "how well it will work."



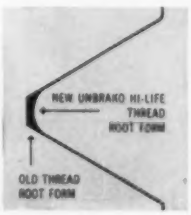
It used to be that all socket head cap screws were *machined* from bar stock, but research revealed that fatigue failures were most likely to occur where the natural lines of strength in the metal were cut. So SPS began forging the heads of UNBRAKO cap screws . . . thus maintaining good flow lines and increasing fatigue strength.



A similar problem in the threads was solved in a similar way. The threads—even more fatigue prone than the head—had always been cut or ground. But now threads were pressed in by precision dies. Once again, maintaining the flow lines of the metal added greatly to the screw's strength . . . and, of course, to the mechanical reliability of your assemblies.



Still, however, there was a lot of room for improvement. Research indicated that there simply was not enough load bearing area under the head. So SPS introduced the UNBRAKO pHd* cap screw, with a larger head diameter and more powerful wrenching socket. The result? Up to 2½ times as much holding power *without* indenting bolted material. This permits higher preloading, which in turn helps prevent loosening under vibration.



One more important stride remained. In the root of the thread were sharp corners where fatigue failure could begin. At the SPS Laboratories for Advanced Research, photoelastic studies made strikingly evident the value of a smoothly radiused root over a conventional flat thread root. And so was born the UNBRAKO Hi-Life thread form, which reduces stress to a minimum, distributes the remaining stress evenly, and increases fatigue life up to 100%.

Now you have at your disposal a socket screw that is stronger in the head, stronger in the thread. The UNBRAKO pHd with Hi-Life threads is the only advanced fastener for the '60's. All this at no additional cost. Write Standard Pressed Steel Co. INDUSTRIAL FASTENER Division, SPS, JENKINTOWN 37, PENNSYLVANIA.

SPS

where reliability replaces probability

**pHd stands for "proper head design"*

CAM BORE PRECISION... AT THREE TIMES THE SPEED OF A BAR AUTOMATIC

STANDARD STYLE 308 BORES AND CONTOURS MINIATURE BEARING RACES FROM BAR STOCK

Take a standard Ex-Cell-O Style 308 Cam Boring Machine, feed bar stock through its Ex-Cell-O Precision Spindles, and add the tooling shown at right.

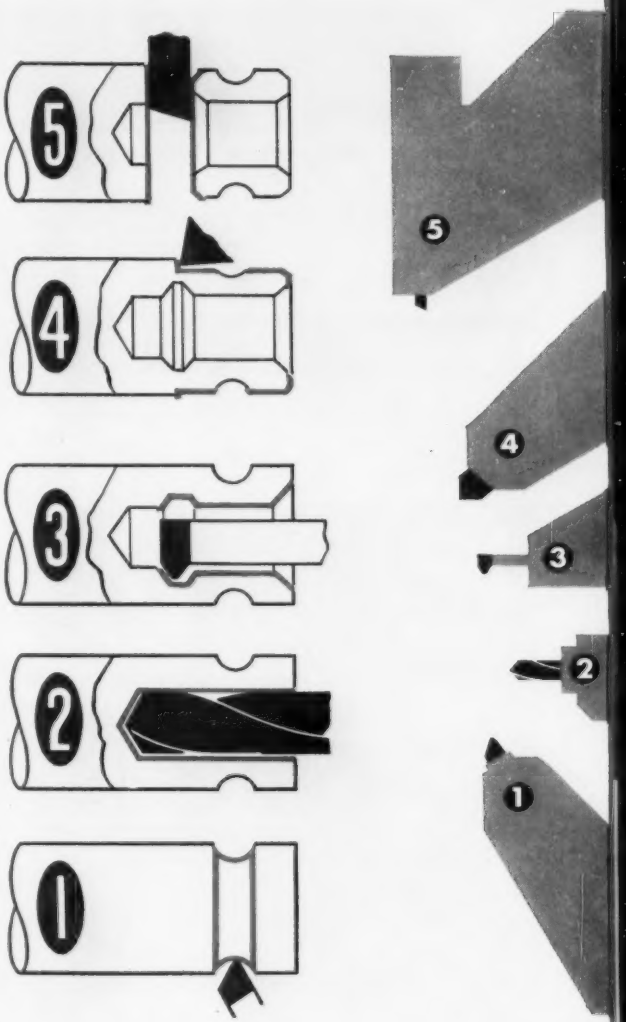
The result: 380 miniature bearing races per hour, gross—produced three times faster, 10 times more accurately, and with more operations and a finer finish than possible with the bar automatic assigned to the same work!

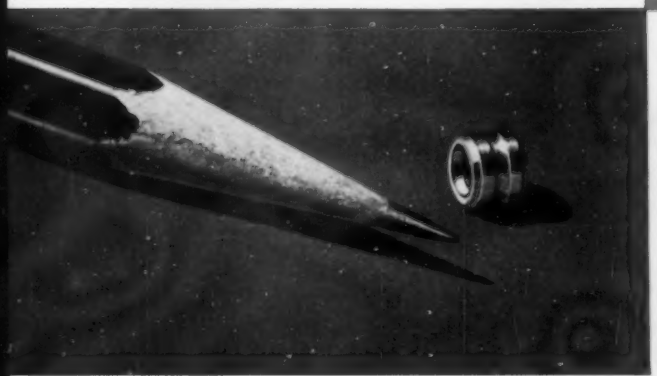
Ex-Cell-O Precision Cam Boring Machines use direct cam action on table and cross slide to perform an endless variety of boring and contouring work. To change the part form, the operator simply changes two convenient cams and tool blocks.

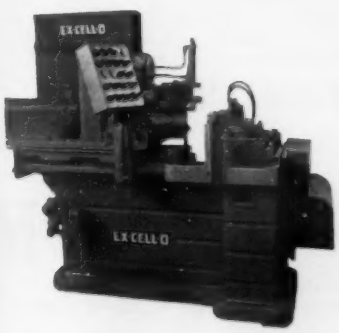
How many ways can you use a versatile boring machine like this in your work? Get the fact-story from your Ex-Cell-O Representative, or write direct for details on the complete line.

MMT-PE

SEE EX-CELL-O's BOOTH 946, NMTBA EXPOSITION







ABOVE: Operations are (1) generate track, (2) drill, (3) back chamfer and contour bore I.D., (4) face, chamfer and turn O.D., (5) chamfer O.D. and cut-off. LEFT: Style 308 Cam Boring Machine. FAR LEFT: Part (shown 2½ times actual size) is 440C stainless steel. Tolerance is held to plus or minus .00025", finish to 20 RMS.

60-28

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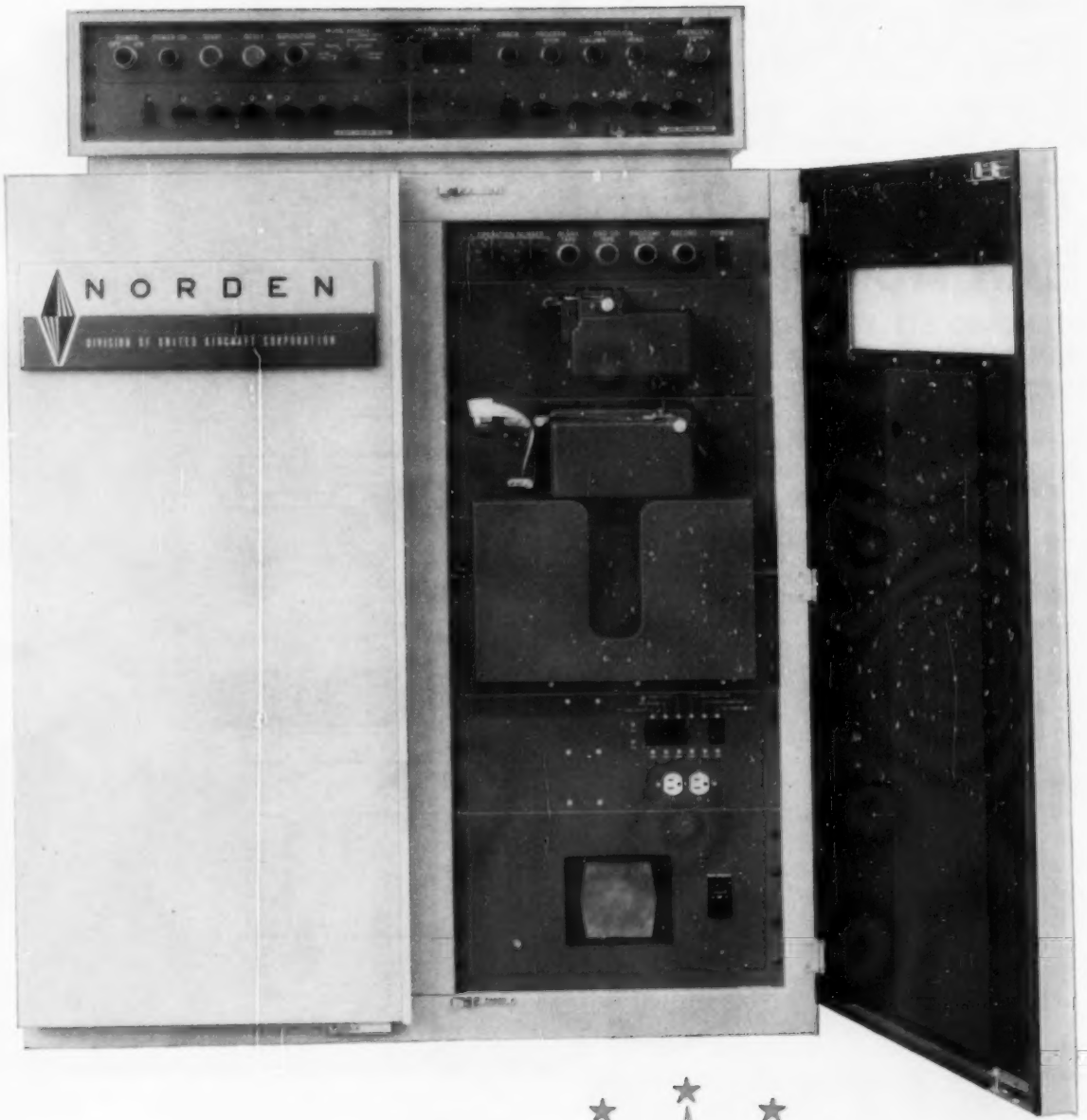


A new concept in Numerical Control

from **NORDEN** ★

DIVISION

NORDEN Modumatic Control Systems feature display of actual position

■ **With Norden unique components you can automate as much or as little as you need.** This new concept in numerical control is made possible by the exclusive design of a position feedback transducer, electronic circuitry and visual display. These units are available in various systems to show the exact position of the moving members of a machine at all times.

EXACT POSITION READOUT

Series 100—This system displays in straight decimal form the exact position of the tool or work piece. One display is used for each axis of motion.

Features—Illuminated numbers, readable from twenty feet—individual plug-in decimal units—display unit can be located on machine or remote.

AUTOMATIC POSITIONING

Series 600—A completely automatic positioning system with input from either manual dial-in switches or punched tape. Display units provide decimal readout of actual position—not command.

FULL RANGE ORIGIN SELECT

Both **Series 100** display and **Series 600** positioning systems can be supplied with full range electronic origin select. Any desired offset is quickly and easily dialed in by the operator on manual selector switches

Features—Eliminates time consuming readings and calculations—eliminates human error—provides offset calculation automatically—displays exact position numerically.

CONTROLLED PROGRAMMING

These systems are available with automatic tape punch units for tape preparation "on the machine." This provides a permanent inspection record or a programmed tape for playback applications.

PROGRAMMED DIMENSIONAL INSPECTION

This new Norden concept now makes possible automatic inspection of parts by measuring their exact shape and contour. Since each point on the part's surface has a digital value this information can be easily programmed. Corresponding points on the actual part can be probed automatically and their dimensions compared with the programmed information. The system can be provided with direct numeric print or readout of actual dimensions, deviations from nominal, or out of tolerance indications. In addition, punched tape output is available.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

When in Chicago see us at the Production Engineering Show, Navy Pier, Booth 221. At the National Machine Tool Builders Exposition, see Norden Controlled Machines exhibited by G. A. Gray Company, Atlantic Machine Tool Works, LaPointe Machine Tool Company.

For more information contact your nearest Norden Representative, 400 Main Street, E. Hartford, Connecticut, JAckson 8-4811, 11 West Monument Avenue, Dayton 2, Ohio, BAldwin 8-4481, or write us at the address below.

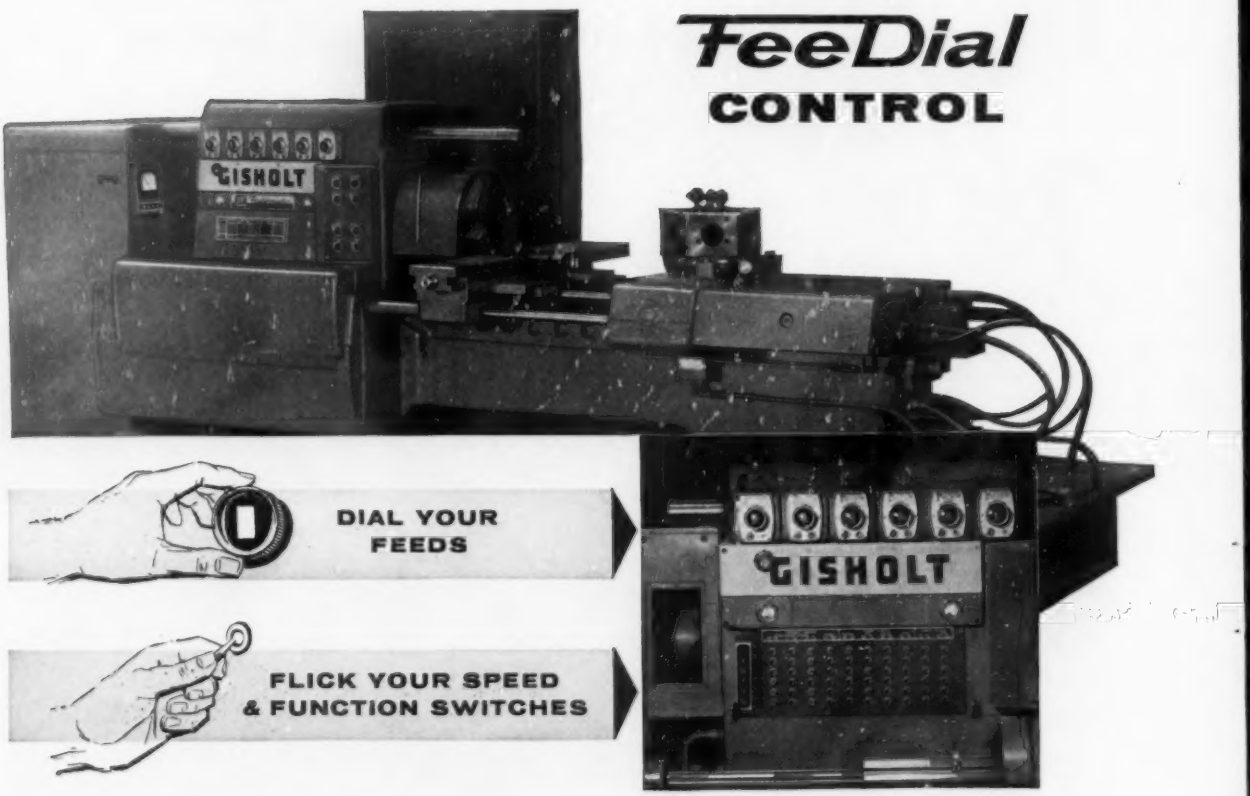
OF UNITED AIRCRAFT CORPORATION

DATA SYSTEMS DEPARTMENT

SANTA ANA, CALIFORNIA

ANNOUNCING

NEW GISHOLT 3F FASTERMATIC WITH *FeeDial* CONTROL



IN JUST 15 MINUTES!

...then set your tools and take your trial cuts. That's how fast and simple it is to set up the new Gisholt MASTERLINE 3F FASTERMATIC Automatic Chucking Turret Lathe!

Only 15 minutes to pre-select feeds, speeds and functions—Now the desired feed rate is individually selected for each tooling station by turning a dial control. Selection of spindle speeds and machine functions is equally fast—just flick toggle switches. You do it all in just 15 minutes.

Completely automatic—But your savings don't end with fast setup. The automatic cycle assures consistent quality at fixed production rates. Any operator, even a new man, can chuck the work, start the cycle and remove the finished part. He has ample time to handle another machine.

What's more fast setup makes the new 3F pay off big on machining small lots—25 to 50 pieces—as well as long production runs. Contact your Gisholt Representative, or write us.

Send for literature—Ask your Gisholt Representative to show you how this new 3F with *FeeDial* can cut costs on your work.

GISHOLT MACHINE COMPANY
Madison 10, Wisconsin

MMT-PE

Turret Lathes • Automatic Lathes
• Balancers • Superfinishers • Threading Lathes
• *Factory-Rebuilt Machines with New-Machine Guarantee*

Investigate Gisholt's Extended Payment and Leasing Plans

1½ times actual size

220 MILLION PIECES

FROM THIS 12-STATION TOOL STEEL DIE

Photo courtesy of Warner Die & Stamping Co., Cary, Illinois, makers of this die.

Tolerances on the intricate shaft-mounted spring shown here are plus .003", minus .000" . . . no burrs allowed . . . and stamping speed is better than 240 a minute. This calls for die-making precision—and a precision die set.

Reliable, consistent precision of the Danly Die Set provides the closure accuracy necessary to the performance of this fine die. After this unusually long run of a precision stamping in a tool steel die, the die set is in good condition.

Danly production methods consistently maintain the highest standards of die set precision through individual control of every critical dimension. Thousands of fine tool and die shops agree that the finest die set obtainable is usually the lowest cost insurance on any die-making investment. Find out how Danly precision can save money for you.

Write for new folder on
"The Importance of Die Set Precision"
Lists and discusses all critical dimensions . . . shows how and why consistent Die Set precision is vital in every die-making operation.
Send for a free copy.

Branches and Distributor Assembly Plants in all Toolmaking Centers

DANLY

DANLY MACHINE SPECIALTIES, INC./2100 SOUTH LARAMIE AVE., CHICAGO 50, ILL.

another Bath Tap job well done.....
for SHAKEPROOF®

These Snow nut tapping machines are using Bath Taps to accurately thread KEPS®—a popular fastener made by Shakeproof Division of Illinois Tool Works, Elgin, Ill

Tapping nuts is far from a "run-of-the-mill" job and the economy and precision of this operation is of prime importance in the manufacture of KEPS,® since these patented fasteners are used wherever accuracy and speed in assembly is vital.

Shakeproof finds Bath Taps have "a very satisfactory production life and stand up well under high speed . . . holding tolerances of the finished part that maintains a fine gaging record" . . . another example of a Bath Tap job well done!

May we have our representative discuss with you, any threading problems that call for speed, accuracy and economy!

KEPS® — cold-formed nuts with free-spinning lock washers—are pre-assembled before being threaded by Bath Spiral Point Ground Thread Taps.

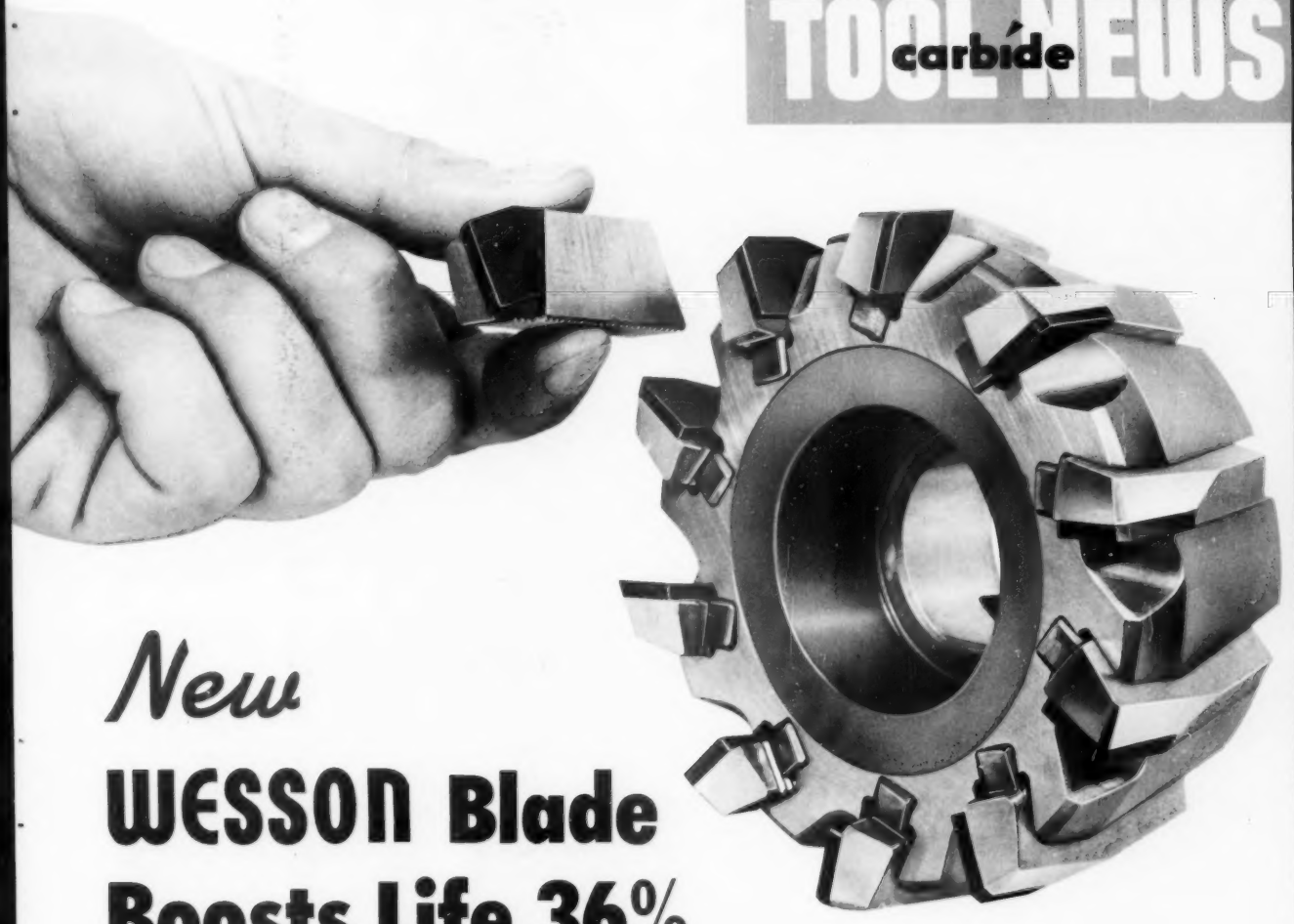
JOHN BATH & CO., Inc.

28 Mann St., Worcester, Mass.

PLUG CYLINDRICAL AND THREAD GAGES • RING THREAD GAGES • GROUND THREAD TAPS • INTERNAL MICROMETERS

TOOL NEWS

carbide



New WESSON Blade Boosts Life 36%

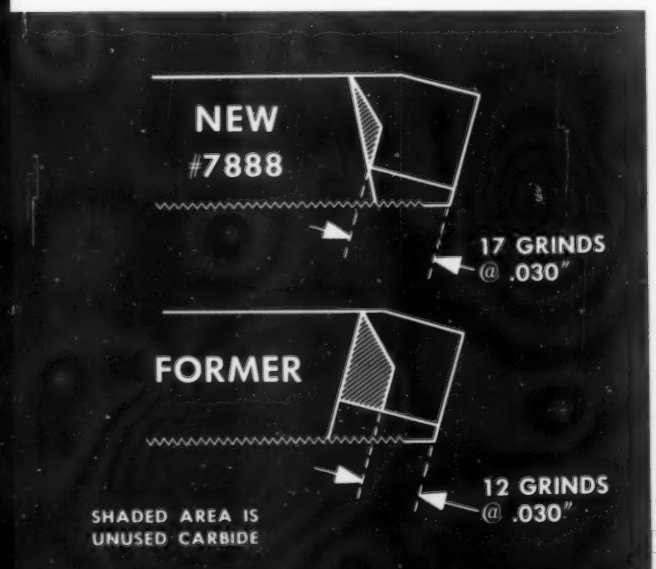
A new blade which provides an automatic average increase of 36% in blade life when milling such metals as cast iron, aluminum, magnesium or steel is now available for all Wesson Rigidcut series 5200, 5400 and 5500 milling cutters.

Assuming that .030 in. is removed per grind, a total of 17 regrinds is possible with the new design as compared with an average of 12 regrinds on the former blade. There is also less carbide left to be scrapped when the blade is "worn out."

The new blades (series 7888) are being made available by Wesson at no increase in cost and may be used, without change, in existing series 5200, 5400 and 5500 Rigidcut milling cutters.

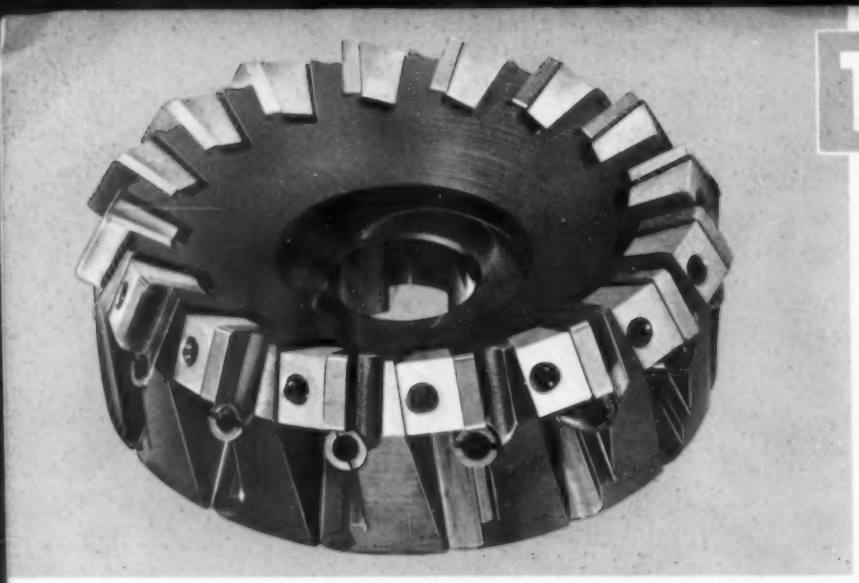
All three series of cutters are available in cutting diameters ranging from 4 in. to 32 in.

Blades are available for either RH or LH cutters.



More grinds and a minimum of carbide waste when "used up" characterize the new Wesson blade for Rigidcut milling cutters.

FOR FURTHER INFORMATION, CIRCLE READERS' SERVICE CARD A-1



carbide TOOL NEWS

Throwaway Insert Cutters Adjustable for First Time

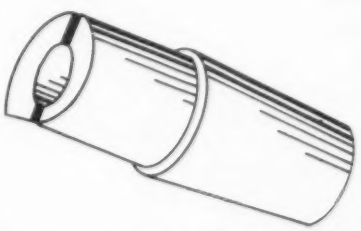
Milling cutters for throwaway carbide inserts with each insert individually adjustable to tenths of a thousandth are now available for the first time. The new development permits the use of throwaway inserts with commercial tolerances without face run-out, and allows cutters to be used for finishing as well as roughing, if desired.

This major breakthrough in the use of throwaway inserts for milling is made possible by an extremely simple device. The axial support for each insert is a cam shaped pin which is taper-locked in position into the cutter body. To advance or retract the insert, a differential screw holding the pin in the cutter body is loosened. The pin is then turned the exact amount desired of insert advance, and the pin is again locked with the screw.

Total adjustment range is .030 in. for each insert, thus allowing for practically any combination of tolerance variations in a milling cutter assembly.

The milling cutter with the new adjustable pin is available as standard in a majority of lead angles and diameters ranging from 5 inches up.

For details, ask for Bulletin #358



To adjust a blade, the blade lock is loosened and the taper lock pin released by turning the screw within the taper lock pin. The pin with its uniform-rise cam seat is then rotated for the desired amount of advance, and pin and blade locks are tightened again.

FOR FURTHER INFORMATION, CIRCLE READERS' SERVICE CARD A-2

Which do you need?

Bulletin MF-260
Complete Prices and Specifications

Bulletin T-160
For Throwaway and Slug Type Inserts

Bulletin B-1259
Micro-Adjustable and Fixed; Single and Multiple

Bulletin MF-360
End Mills, Counterbores, Lathe Centers, Core Drills, Reamers, Vises

Bulletin No. 358
Covering Throwaway and Rigidcut Milling Cutters

All literature requests should be on company letterhead

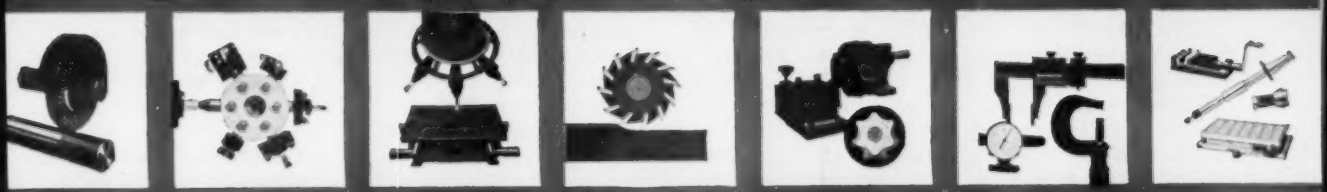
tools Wesson carbide Wessonmetal

WESSON COMPANY, DEPT. AD
1220 Woodward Heights Blvd., Detroit 20, Mich.

IN CANADA:
WESSON CUTTING TOOLS, LTD.
93 Judge Road, Toronto 18, Ontario

LITHO IN U.S.A.

to help you make more for less...



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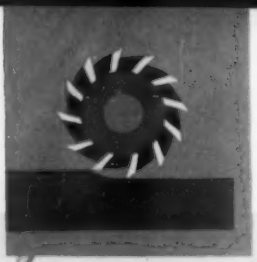
IMTS

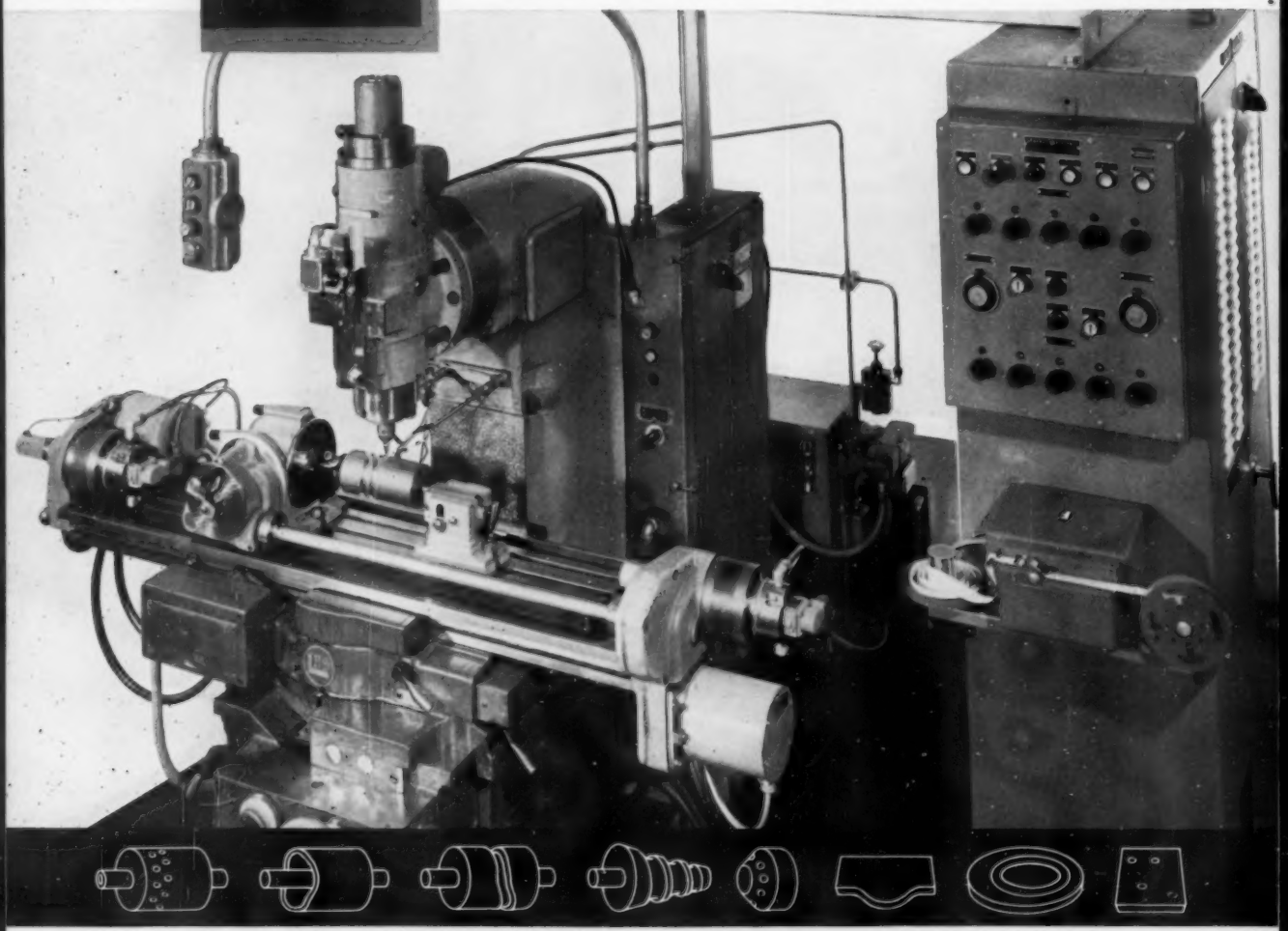
MACHINE TOOL
EXPOSITION
BOOTH 405

MMT·PE

Booth 452
Machine Tool
Exposition



TO HELP YOU MILL MORE FOR LESS



The NUMERICAM can be readily programmed for milling any type of cam path or hole pattern — in cylindrical, conical, or flat surfaces; on plate cams or templates.

Small research-type computers are used for data calculation, and the tape is standard 8-channel type. Tape for simple hole patterns can be produced on the Flexowriter.

New Brown & Sharpe tape-controlled NUMERICAM saves up to 90% of cam layout and machining costs

The NUMERICAM is a revolutionary new system for prototype cam cost reduction. The machine is a B&S No. 2 Vertical Milling Machine, arranged for tape control. Modifications include hydraulic power down feed to the cutter spindle, and electrically controlled servo drive to work head and table. A G-E Mark II Positioning Control governs the fully automatic cycle. Other tape control equipment of this type can also be used.

The computing and control equipment used is relatively simple, because the NUMERICAM is designed for point-to-point cam-path machining. The investment required is much lower than for the full contouring method.

Cams of average throw (6″ or less) can be held to a tolerance of ±.0002 inch and hole pattern spacing to a quarter-thousandth.

Get full information on the NUMERICAM. Find out how you can turn out precision machined cams in one-tenth the time required for manual methods, at savings that will write off the investment in record time. Write: Machine Tool Division, Brown & Sharpe Mfg. Co., Providence 1, R. I.

Brown & Sharpe PRECISION CENTER

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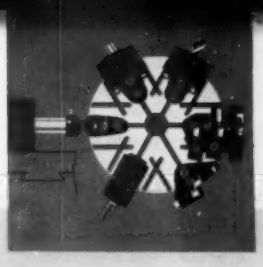
Booth 452
Machine Tool
Exposition



TO HELP YOU REDUCE
SCREW MACHINE PRODUCTION COSTS

B&S No. 4 . . . the big Automatic for big savings on long or short run jobs in the 2″ range

The Brown & Sharpe No. 4 Automatic Screw Machine is the profitable partner in productivity to the B&S No. 00 and No. 2 Automatics. It turns out the larger work with equal efficiency, precision, and fine finish. You can keep it busy day after day, and it pays off on moderate volume work as well as big production.

Easy accessibility of the turret face speeds set-up, avoids fatigue caused by difficult "reaching." The operator can stand 20 inches closer when adjusting tools than he can with comparable machines. Because set-up is so much easier and faster, the No. 4 Automatic is the practical machine for shops now producing a variety of parts in job lots on turret lathes or multiple-spindle machines, at high hourly rates.

Find out how the No. 4 Automatic can fit into your screw machine production requirements, and pay you the highest return on your dollar investment. Takes stock up to 2″ dia. (up to 2⅜″ dia. with outside feed), and turns any length up to 5″. Spindle speeds, 1965 to 17 rpm, provide range suitable for any machinable material. Write: Machine Tool Division, Brown & Sharpe Mfg. Co., Providence 1, R. I.

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Exposition

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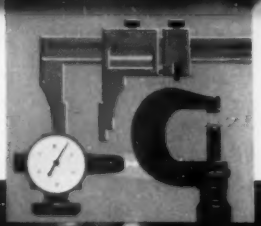
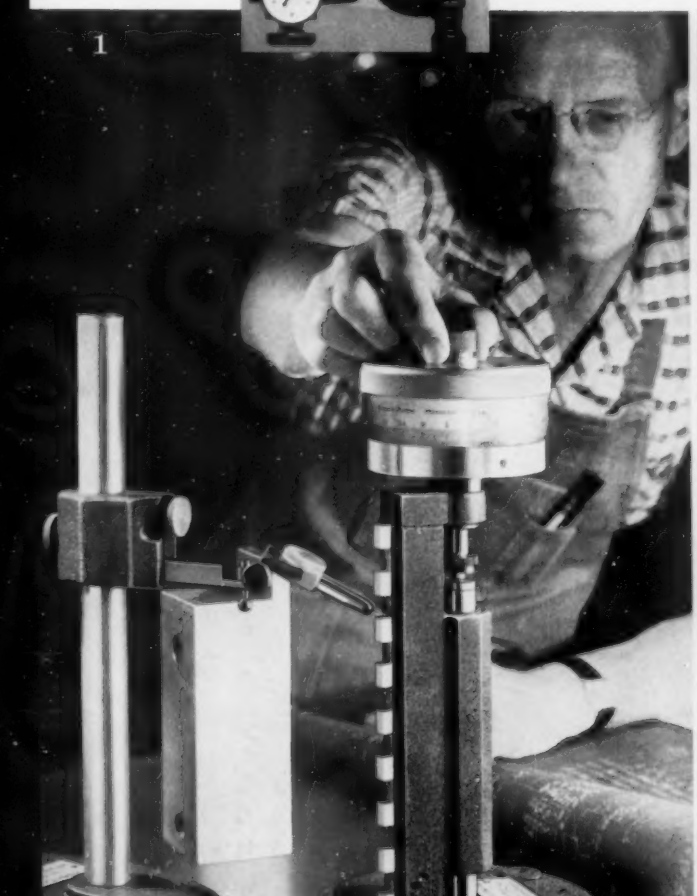
Machine Tool
Exposition



TO HELP YOU MAKE PRECISION MEASUREMENTS EASIER AND FASTER . . .

1



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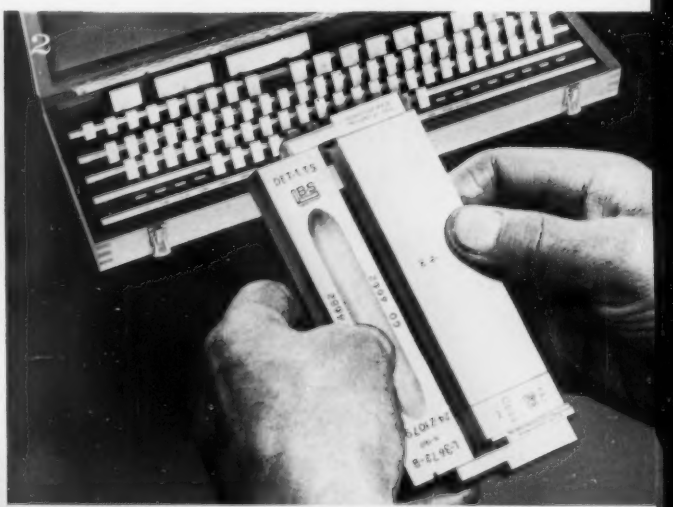

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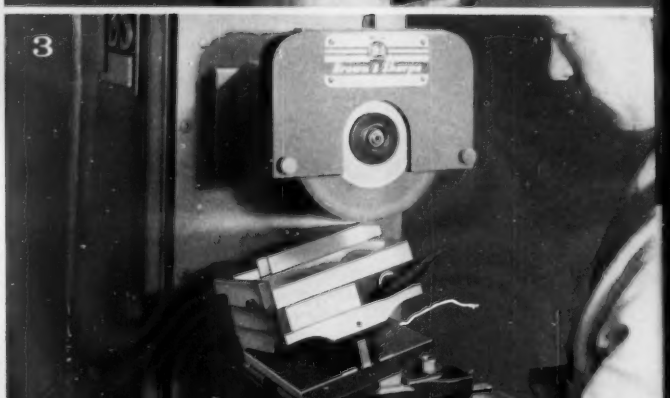

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Machine Tool
Exposition

TO HELP YOU GRIND MORE FOR LESS

Designed by cutter specialists for extra savings - B&S No. 10N and No. 5 Cutter and Tool Grinding Machines

Brown & Sharpe Cutter and Tool Grinding Machines provide the advanced features today's toolrooms need to handle more kinds of sharpening jobs, to turn out more work per day, and to maintain consistent high precision.

Many of these design advantages are available only in B&S Tool Grinders, for logical reasons. Brown & Sharpe is a leading producer of milling cutters. B&S cutter specialists collaborate on design of the machines. The No. 10N and the No. 5 are the results — two machines that set the standard for top economy in tool maintenance.

Brown & Sharpe design provides *precision glide* roller-bearing table movement — wheel mounting at *both ends* of the spindle — cutter bar attachment that *eliminates* critical table setting on peripheral sharpening. Both machines are 100% operative from any point in 360° work area.

The No. 10N (left), capacity 10" x 29", will handle all your sharpening jobs. With optional universal equipment, it can also be used for light external and internal cylindrical grinding and surface grinding. No. 5 has ample capacity, 6⅜" x 17½", for routine sharpening — takes less than 8 sq. ft. of floor space. Standard work head tapers fit all commonly used collets and adapters.

For full information, write: Machine Tool Division, Brown & Sharpe Mfg. Co., Providence 1, Rhode Island.

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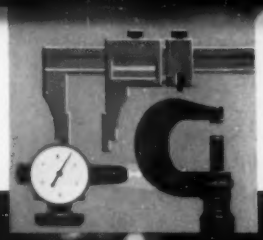
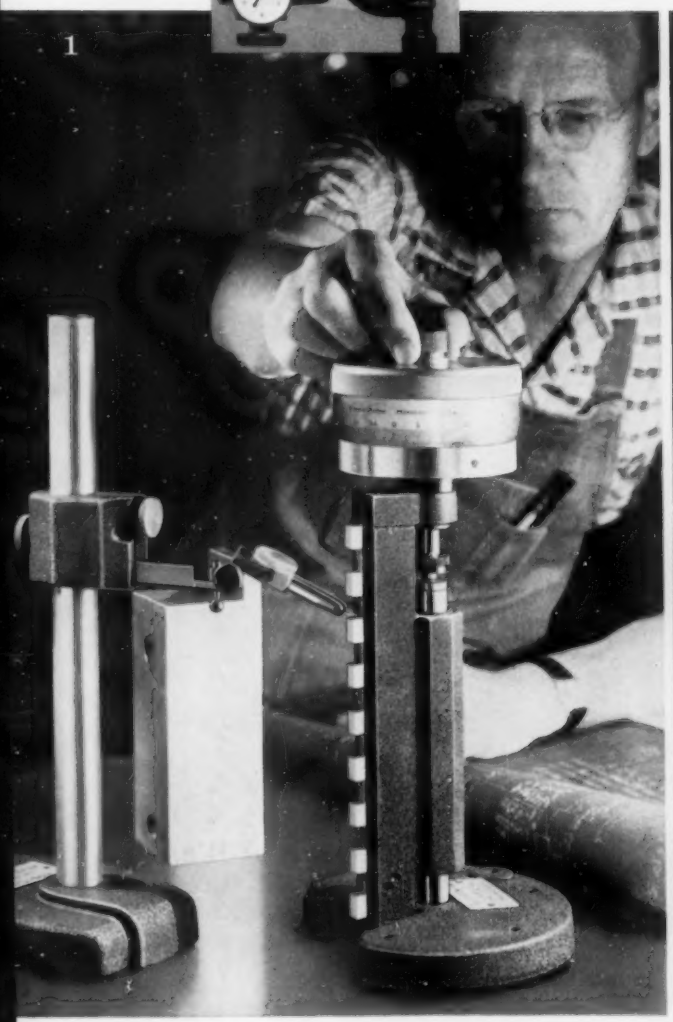
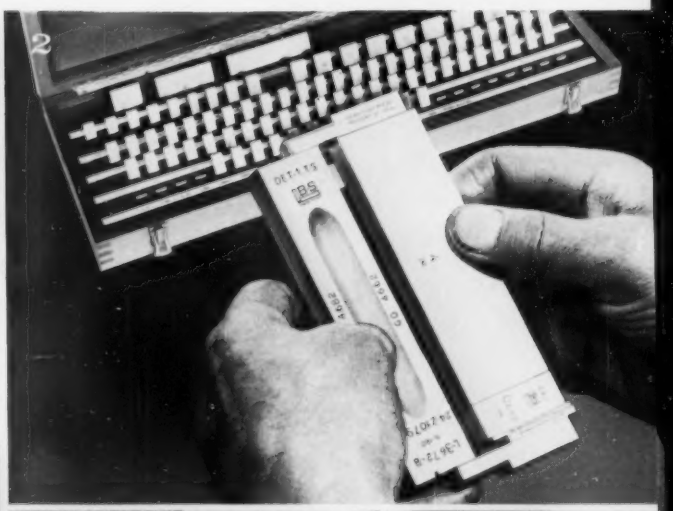
Machine Tool
Exposition



TO HELP YOU MAKE PRECISION MEASUREMENTS EASIER AND FASTER . . .





In your lab or on your production line — 3 ways to assure Brown & Sharpe precision

1 B&S Hite-Set® with new 4" Super-Speed head, sets any height in its range, quickly, with gage-block accuracy. Micrometer head is the biggest in the industry. It actuates a series of .5000" blocks, accurate overall to 50 millionths, from which measurements are taken — spreads ten-thousandth divisions out so they can be easily read at arm's length. Hite-Icator®, also available, is the same tool with a reference dial added to indicate thousandths. Both tools are available with 1" to 10" or 1" to 20" range. They are the *most economical* tools of this type, based on price per inch.

2 B&S Johansson® and Thrift® Gage Blocks are the foremost measurement standards in industry. These hand-lapped "gems of precision" are available in AA, A, B and Thrift classes of millionths accuracy — to suit every gage block need at minimum cost.

3 B&S Sine Plates and magnetic-top Perma-Sines, set to gage blocks, establish the most precise angles you can get for inspection and machining. They are accurate overall to 2 ten-thousandths — beautifully hardened, finished and fitted, yet reasonably priced. Brown & Sharpe Mfg. Co., Providence 1, Rhode Island.

INDUSTRIAL DISTRIBUTION — THE RIGHT HAND OF PRODUCTION

Brown & Sharpe PRECISION CENTER

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IN ONLY SECONDS YOU'RE SET WITH PIPE MACHINERY HILO PLUG GAGES

Here at last is a faster, more dependable method for setting ring gages and other adjustable instruments for the inspection of male threaded parts.

When set to the front portion, if the back portion stays out, the ring is in size. It's just that quick, just that certain!

In employing standard setting plugs, chances are it takes your operator unnecessary time to set a ring gage by the feel and shake method. With a new Hilo it takes only seconds and resetting is kept to a minimum.

For more complete information on how Pipe Machinery Hilo Set Plugs can save costly inspection time – write today.

THE PIPE MACHINERY COMPANY. 29100 Lakeland Boulevard • Wickliffe, Ohio • Greater Cleveland

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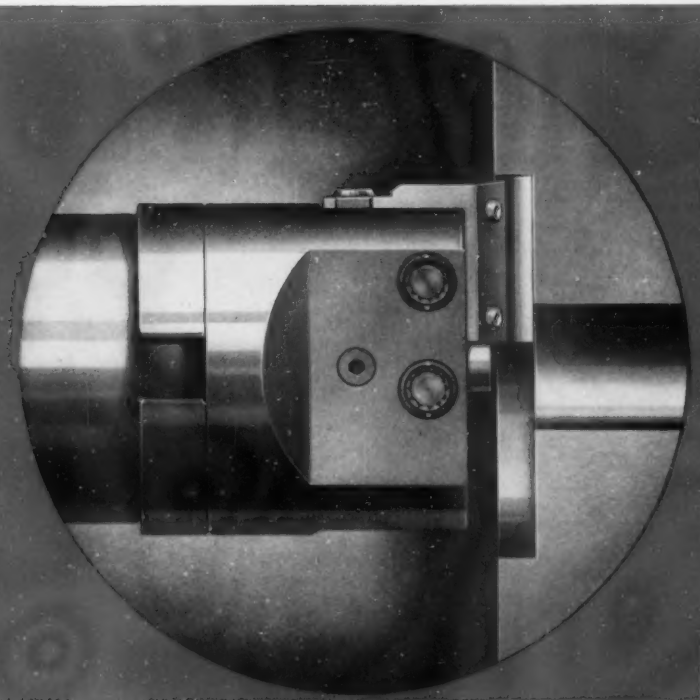
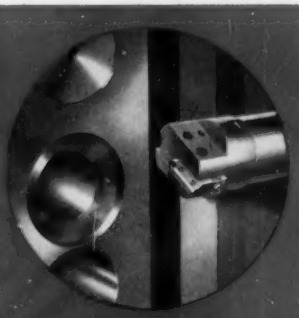
NEW FROM **FAIR STREET** • HOME OF MICROBORE

microface®

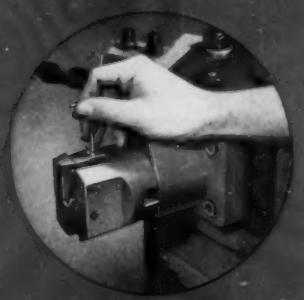
ADJUSTABLE BLADE FACING HEAD

(Patent Pending)





Adapters accommodate 5 standard Microface head sizes for all machines.



Quickly installed and adjusted to .001" on dia. while on the machine.

For boring machines, turret lathes and heavy drilling equipment, this new addition to the Microbore Tooling System bores, faces or spot faces wide surfaces from 1½" to 8½" dia. without special tooling. Often eliminates the necessity of generating faces by slow cross feed methods. Dovetail blade holder mounting in the rugged, one-piece head eliminates chatter, assures consistent accuracy, fine surface finish and prolongs blade life. Adjustment of interchangeable high-speed steel or carbide blades is fast and accurate. *Blades replaceable with a minimum of down time without removing head from the machine.*

Write for technical 4-page brochure.

DeVlieg Microbore® System

DE VLIEG MICROBORE • DIVISION OF DE VLIEG MACHINE COMPANY

Fair Street, Royal Oak, Michigan

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Modular Profiling...Pattern for Assured Accuracy

Progressive manufacturing methods . . . like *modular profiling* . . . are among the means which enable National Tool Company to pass on the benefits of assured accuracy and faster service to its customers.

By constant improvement of techniques such as this, better products result . . . to meet the increasingly exacting demands of the metalworking industry . . . to provide quality and performance *dependability*.

NATIONAL Tools CLEVELAND

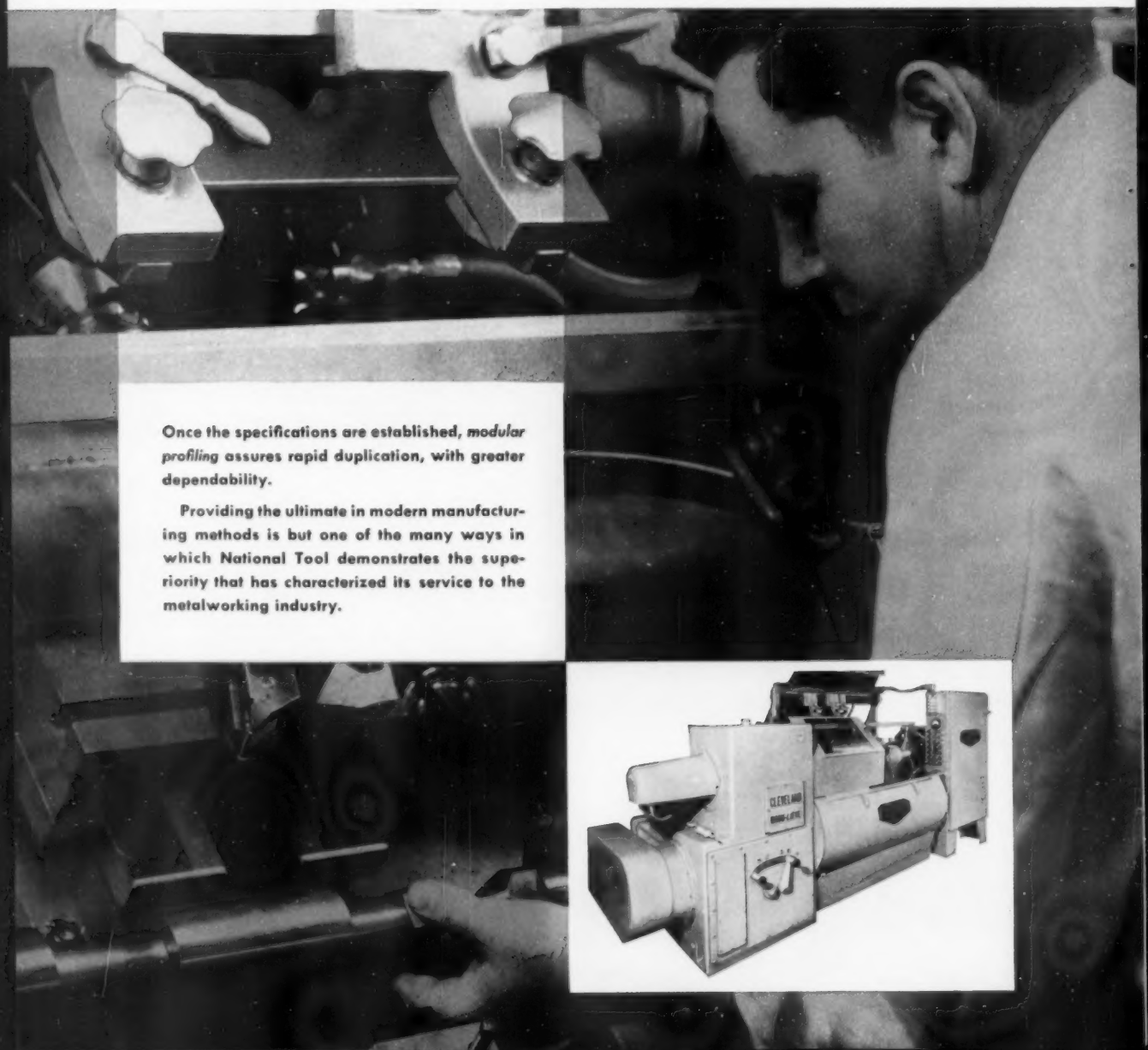
NATIONAL TOOL COMPANY

A DIVISION OF

National Cleveland Corporation, 11200 Madison Avenue, Cleveland, Ohio

For more than a half century National Tool has supplied high quality precision cutting tools to the metalworking industry.

For your special cutting tool requirements call your National Tool representative.



Once the specifications are established, *modular profiling* assures rapid duplication, with greater dependability.

Providing the ultimate in modern manufacturing methods is but one of the many ways in which National Tool demonstrates the superiority that has characterized its service to the metalworking industry.

Only EX-CELL-O Contour Projectors* Give You ALL!

✓ CHECK THESE FEATURES!

☐ **LARGEST WORK AREA**—Constant eight inches of work space from lens to focal plane regardless of magnification. Plenty of room for large objects.

☐ **UNSURPASSED ACCURACY**—Famed Kodak Ektar® lenses guarantee reliable measurements with clear *accurate* images over entire screen.

☐ **BRILLIANT SURFACE ILLUMINATION**—Original design, "direct-on" built-in surface illuminator gives extra bright image and *full work clearance* at all magnifications.

☐ **ERECT—UNREVERSED IMAGE**—Correct, normal appearing images at all magnifications, eliminate confusion, simplify operation and save time.

☐ **COATED LENSES AND MIRRORS**—Produce clear sharp images characteristic of Ex-Cell-O Contour Projectors. Have been standard on all models for many years.

☐ **BRIGHT, GLARE-FREE SCREEN**—The "Fresnel" lens is exclusive with Ex-Cell-O, permits operator to see entire screen evenly illuminated from normal position. No "hot spots".

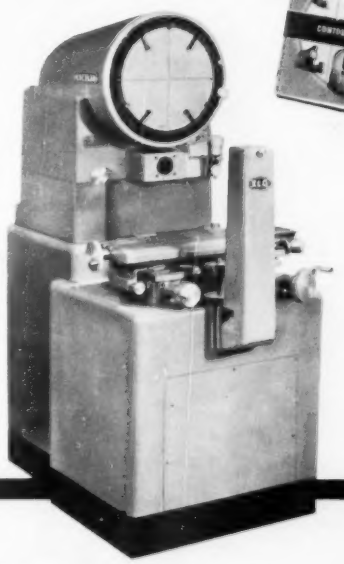
☐ **TRUE MEASURING PRECISION**—All Ex-Cell-O Contour Projectors not only read to tenths—they measure to tenths.

☐ **FINGERTIP CONTROLS**—Ex-Cell-O Contour Projectors are designed for maximum convenience and comfortable all day operation. Easy-to-reach controls.

☐ **RUGGED CONSTRUCTION**—The long established reputation of Ex-Cell-O for precision and quality assures years of trouble free operation.

☐ **YOUR OGP REPRESENTATIVE**—Will help you make sure you get the right Ex-Cell-O Contour Projector to fit your optical gaging requirements. Call him today!

Write for new edition of EX-CELL-O Contour Projector Booklet—Available Now!



*Manufactured by EX-CELL-O Corporation at Detroit, Mich.

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(A subsidiary of EX-CELL-O Corporation)

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Make a Fast...Easy...Accurate Selection of

and know your size, shape, and grade are

The Allegheny Ludlum Tool Steel

STEELECTOR

- ✔ every type needed for 96% of all tool steel applications
- ✔ easy selection of the proper tool steel based on its individual characteristics
- ✔ stock shipment of grade and size assured at selection time

the Proper Tool Steel for any Application

Available with the A-L Steelector Program

easy answer to an old problem

Starting right now, the common problem of selecting the right tool steel for any job can become a thing of the past. With A-L's new STEELECTOR Program, you can make a *first time choice* of the proper grade for any application . . . and make it FAST, almost at a glance.

eliminates guesswork

The STEELECTOR is ACCURATE, eliminating guesswork, trial runs, and expensive mistakes. And best of all, the STEELECTOR gives you a choice of tool steels that are AVAILABLE . . . in stock, right now! And they'll *stay* available . . . with a new, increased stocking program. STEELECTOR Grades are stocked according to a study of today's needs and will be reviewed periodically to fit changing requirements.

here's how it works

In the new program, a STEELECTOR Card covering each group of steels (Tool Room, Hot Work, and High Speed Grades) will help you select one particular grade as the best for your application. The STEELECTOR presents five basic tool steel properties—Abrasion Resistance—Toughness—Size Stability—Machinability—Red Hardness—as bar graphs, with the length of the bar showing the extent of each property in every STEELECTOR Grade. Find the properties most important to you and, by inspection, pick the grade with the characteristics you need.

availability assured

There is a separate Data Stock List for each STEELECTOR Grade, showing its complete range of warehouse stocks, as well as technical

data and basic application information. So, you can be sure the grade, size, and shape of your choice is in stock.

quality assured

And you can count on Allegheny Ludlum quality in every STEELECTOR Grade. They are selected from the complete line of A-L Tool Steel and made under the rigid quality control standards of all A-L products.

details available

It's all explained in the colorful A-L Tool Steel STEELECTOR Booklet, which includes STEELECTORS for the Tool Room Grades, Hot Work Grades, and High Speed Grades, and explains the Data Stock Lists for every STEELECTOR Grade. Ask your Allegheny Ludlum Sales Representative for your copy, or write: Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa. Address Dept. Ins. 7.

STEELECTOR PROGRAM

ALLEGHENY LUDLUM

Tool Steel warehouse stocks throughout the country

For best results in Surface Grinding . . . Always Use Blanchard Wheels!

The flexibility in application of your Blanchard Surface Grinder enables you to attain peak production at lowest cost on hundreds of different grinding jobs. *But, it is very important that you use the right wheel for each job!*

Blanchard makes and stocks a great variety of silicate, resinoid and vitrified bonded wheels and segments. Ask your Blanchard representative to help you select the wheel – or wheels – best suited to your requirements. Call or write him today. And may we send you a copy of "The Art of Blanchard Surface Grinding" (4th Edition)?

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For new, set-it-and-forget-it fastener control...

INTERCHANGEABLE LEVER AND PISTOL GRIP MODELS
TORQUE RANGE FROM 2 IN. LBS. TO 85 IN. LBS.
QUIET, MUFFLED OPERATION
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TRY THIS NEW TOOL ON 10-DAY FREE TEST

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One screw or 1,000, Master Power's new Torque Limiter gives you the never-failing, fool-proof torque control that prevents damage to screws, nuts or work—stops costly reworking—lengthens bit life many times over—eliminates need for hand torque wrenches.

Before you settle on any assembly tool, try our free 10-day trial! Use the new Torque Limiter on your jobs. See how Master Power *customizes* its tools to your needs. Mail the coupon today.

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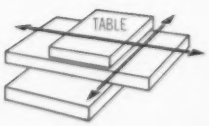
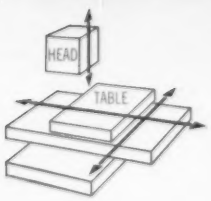


1 This two-axis Sundstrand Jigmatic positioning table placed under existing machines, such as radial drills, eliminates jigs and fixtures, provides positioning accuracies to ±.001″, greatly increases productivity. Table working surface is 20″ x 30″.



2 A moderately priced machine with two-axis positioning of work is provided by mounting one or more vertical heads on a simple frame above a Sundstrand numerically controlled Jigmatic table.

"Engineered Production" concept applied to numerical control

. . . a system of machines to best meet the economic requirements of your production

There is no more reason to adapt your production to a particular type of numerically controlled machine than there is to adapt it to conventionally controlled machines. New Sundstrand machines with numerical point control have been developed to meet the Sundstrand "Engineered Production" concept — which evaluates your job requirements from the standpoint of methods and economics and then provides the machine that best fits these requirements.

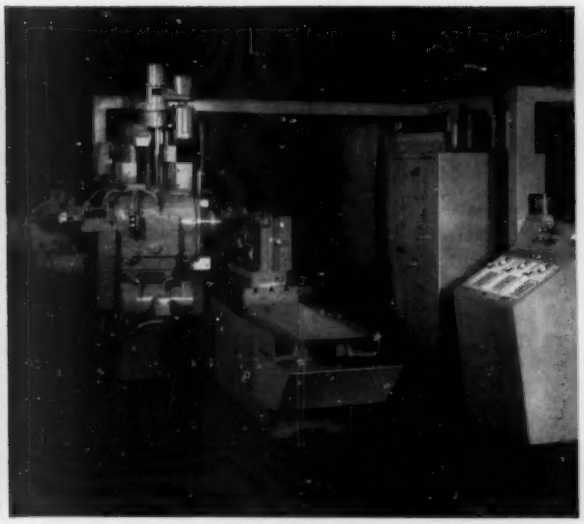
Some of the machines illustrated are completely new types. Others are familiar Sundstrand machines with necessary design modifications to take the fullest advantage of numerical control. Any one of them is ready to fit right into your production line — to replace one or more machines now performing the same operation, or to combine several operations now performed on different machines.

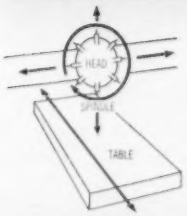
Other new Sundstrand numerically controlled machines now being built will extend the system to encompass a far greater range of requirements. Watch for their announcement — and be sure to see Sundstrand numerically controlled equipment at the Machine Tool Exposition, space No. 1014.

SUNDSTRAND

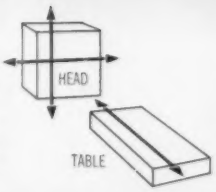
SUNDSTRAND MACHINE TOOL

BELVIDERE, ILLINOIS • DIVISION OF SUNDSTRAND CORPORATION

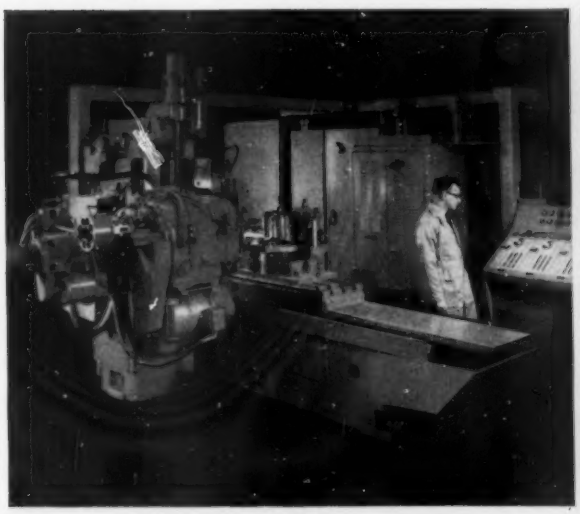


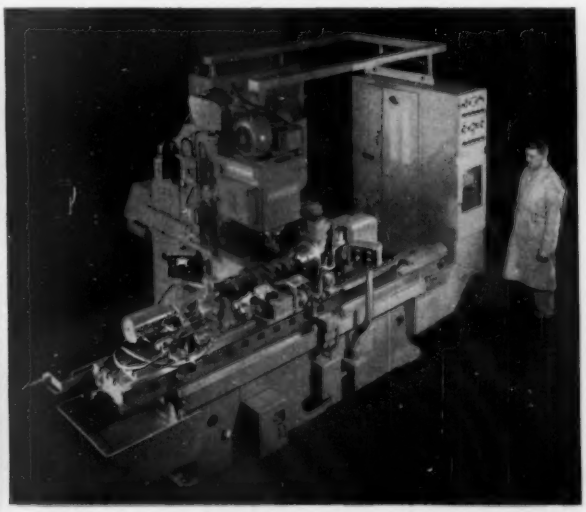


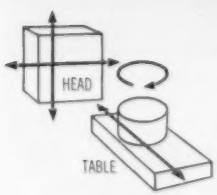
3 This new turret-type machine with a 40″ x 60″ table, provides the necessary range for precision machining of workpieces too large for the standard Jigmatic table. The head travels on a crossrail which is adequately supported at each end by a vertical column. All motions, including turret rotation, are numerically controlled.



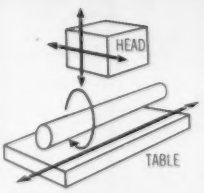
4 This three-axis machine with quick tool change handles a wide range of boring, drilling, reaming, tapping, milling, and related operations. The basic machine is built up of proven Sundstrand Rigidmil components, modified for numerical control. Table size and table and column travel can be furnished to suit job requirements.



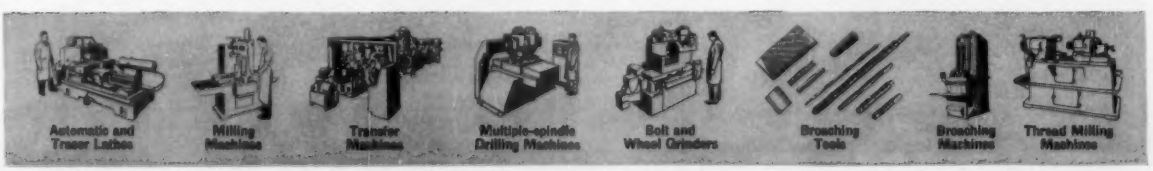




5 This three-axis machine is equipped with a numerically controlled index fixture which presents all four sides of the workpiece to the cutting tools. Otherwise, it is identical to the machine described in paragraph 4 above.



6 This machine typifies the Sundstrand "Engineered Production" approach to machining. Designed to mill locating spots on six different crankshafts, the basic components are standard. The spindle and workpiece are numerically positioned.



Metallurgical Memo from General Electric

GENERAL ELECTRIC ANNOUNCES PRE-HONED

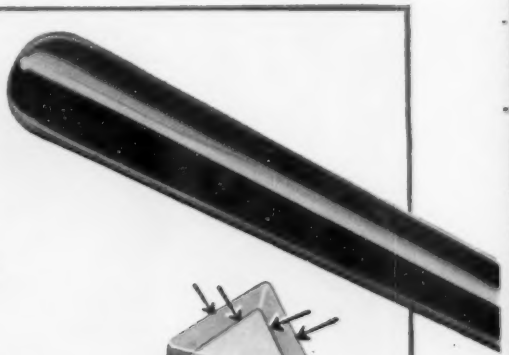
Hand-honing is inaccurate, time-consuming—often results in premature chipping and breaking.

Chamfered, or ground-flat, edges are geometrically weaker than a radius and are more easily chipped or broken.

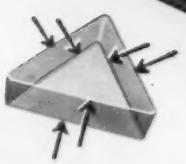
Unhoned or as-ground inserts show rough edges—result in unpredictable tool life due to chipping.

Now you get more predictable tool life... lower cost per cutting edge ...no hand-honing cost!

Pre-honed inserts with uniform, precise honed edges offer top strength; improve tool life predictability.



Additional savings result through the elimination of costly and often inaccurate hand-honing methods.



Because chipping and breaking are minimized, pre-honed Carboloy inserts result in lower average cost per cutting edge.

TOPS IN TOOLING QUALITY

From the research and quality-control facilities of the Metallurgical Products Department of General Electric comes the outstanding quality tooling line in the metalworking industry. The new Carboloy pre-honed inserts, as well as the complete line of Carboloy toolholders, inserts, insert seats, convertible seats, and brazed tooling, are designed to meet every tooling need efficiently and economically.

CARBOLOY® INSERTS

Delivered ready-to-use . . . honed to a precise radius . . . promise BETTER PROFITS THROUGH BETTER TOOLING

Now General Electric Carboloy inserts are pre-honed *at the factory!* Here's what it means to you:

1. An insert with edges honed to precise *radii* gives the strongest geometric shape to withstand cutting pressures. This reduces the chance of chipping—increases the predictability of tool life. Hand honing *cannot* achieve precise radii—G-E pre-honing can . . . and does!

2. Since chipping is minimized, fewer cutting edges are wasted. The result is lower cost per cutting edge.

3. Since inserts come pre-honed and ready-to-use, the labor cost and inaccuracies of hand honing are eliminated. This more than offsets the additional charge for pre-honing.

4. Pre-honed Carboloy cemented carbide inserts have standard edge radii honed to a greater or lesser degree, depending on the job to be done. You'll *know* the honing is right!

Ask your Authorized Carboloy Distributor about pre-honed Carboloy inserts, convertible seats, toolholders, and brazed tools. Or, write directly to: *Metallurgical Products Department of General Electric Company, 11101 E. 8 Mile Road, Detroit 32, Michigan*

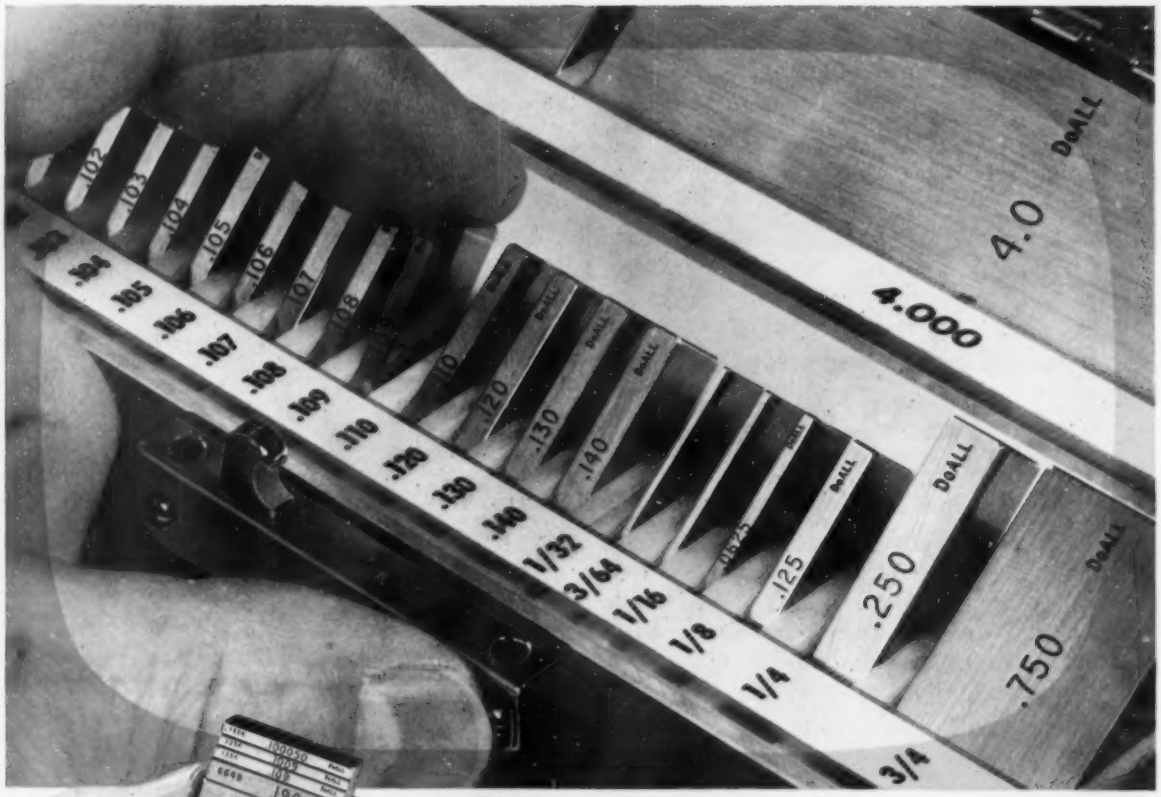
Shown here, both under magnification and graphically, is an edge of the new Carboloy pre-honed insert. Radius is geometrically ideal to minimize chipping, extend tool life many times.

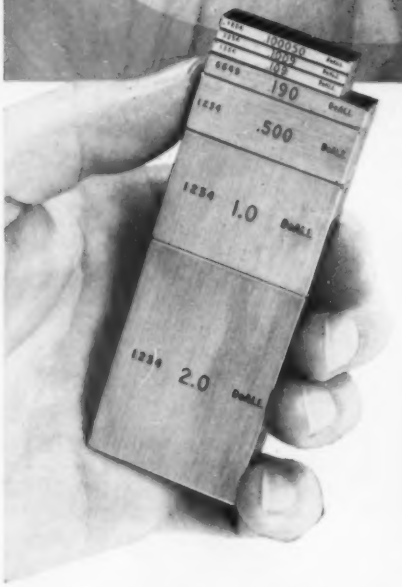
CARBOLOY®
CEMENTED CARBIDES

METALLURGICAL PRODUCTS DEPARTMENT

GENERAL ELECTRIC

CARBOLOY® CEMENTED CARBIDES • MAN-MADE DIAMONDS • MAGNETIC MATERIALS • THERMISTORS • THYRITE® • VACUUM-MELTED ALLOYS





The clearly etched size designations on the new DoALL gage blocks make it easy to check the combination *after wringing*. The figures form a column that's quickly added when verification is necessary.

2 IMPORTANT IMPROVEMENTS

to save time and increase service life of standard steel or stainless steel

DoALL GAGE BLOCKS

Just out! A brand-new self-indexing pocket case that saves time in finding and removing the *correct* gage block—without touching other blocks or gaging surfaces. And a new and better way of showing size designations on the individual gage blocks.

DoALL's new index case is designed to show the size marking on the block itself and its correct slot in the case at all times—even when the case is completely filled. It's faster and easier to use.

The new method of etching size designations on the side, or non-gaging surface, lets the user see the size of each block at all times—even *after the blocks have been wrung* together. No more disassembling to double-check the combination. And the size markings line up to form a column that's easily checked against your list of required blocks.

DoALL gage blocks have long been quality leaders in accuracy, hardness, long life and now, the only blocks available in ultra-stable stainless steel. These important improvements are unmatched—anywhere. Call your local DoALL store and ask the gage specialist for complete information!

During the Machine Tool Exposition, see DoALL's Demonstrations at the Coliseum, Navy Pier, Hall of Progress.

GB-38

This is a typical DoALL Store

The DoALL Company, Des Plaines, Illinois

Call Your DoALL Sales-Service Store

Permanent Vacations

You are probably making plans now for your summer vacation. Wouldn't it be nice to have a permanent vacation with an income guaranteed to take care of your needs?

We have just completed negotiating a new contract with our plant union that provides four weeks vacation for all our employees after twenty years of service. We pointed out to the bargaining committee that a four week vacation will mean added costs and less production which would make it more difficult for us to meet our already tough competition and will make it much harder to meet our foreign competition who's labor rates are from one-third to one-tenth ours. We also pointed out that vacations for many of our people might become permanent if we could not meet competition and secure enough orders to provide work for our people.

Permanent vacations with pay will never come. Paid vacations can only come from profitable operations. A permanent vacation *without pay* could come if the company you work for isn't able to meet its competition. You, as a tool and manufacturing engineer play the leading role in your company's ability to meet competition and stay in business. It is your responsibility to know and apply the latest manufacturing technology (know how) so your company's costs will be low enough for your salesmen to meet and beat competitors.

Our Society makes it possible through THE TOOL ENGINEER, chapter technical meetings, expositions, seminars, books, tours and many other activities for you to keep up-to-date with the latest developments in manufacturing technology. There is an expression we used to use on the farm, "You can lead a horse to water but you can't make him drink." Our Society can present the latest manufacturing developments to you—but it is up to you to "drink it in" and then apply it in your company in order to keep competitive.

Your income, your security, your future vacations depend on your learning and applying the most effective manufacturing technology available.

To ensure your future vacations are not permanent ones *without pay* better take along some recent issues of THE TOOL ENGINEER on your "paid" vacation this year.

Dale Long

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KB King Post Tool Inserted
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FT2 Front Slide Tool #2
RT Right Slide Tool
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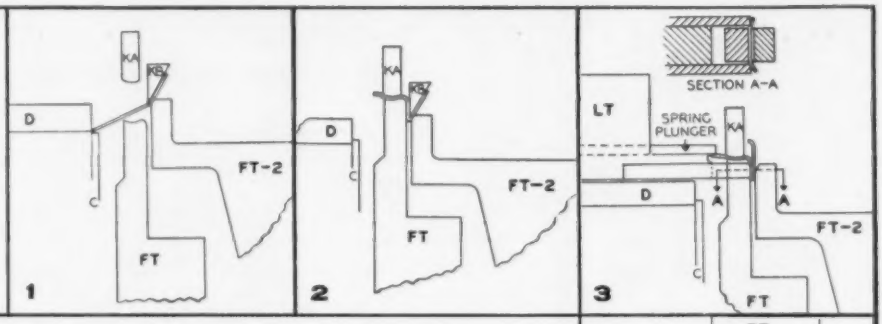
C Cut-Off
D Cut-Off Die



JOB SHOP MAKES COMPLEX PIECE IN ONE OPERATION

on a NILSON S-3-F FOURSLIDE with its built-in 20 TON PRESS

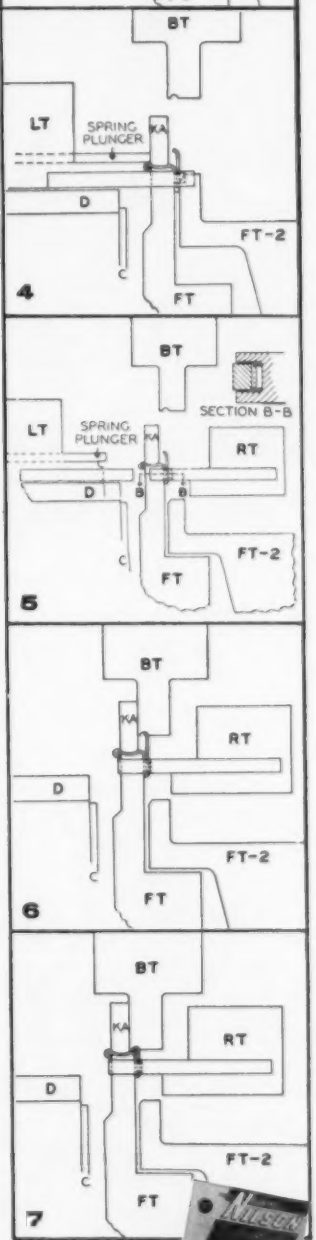
Design, ingenuity, simple tooling, and a NILSON FOURSLIDE solved this tough problem for Dayton Coil Spring Company, Dayton, Ohio. They put this job on a NILSON S-3-F for speed and economy of tooling, instead of in their stamping department.

They benefited first by getting into production faster than possible with complicated cams and progressive dies necessary to do the same job. Second, even though the part is complex, the FOURSLIDE tooling is simple and comparatively inexpensive. Third, the entire piece is formed completely in one machine, resulting in equipment and manpower savings.

The built-in 20 Ton Press produces blanks, from .025" x 1.125" cold rolled ribbon steel, which are continuously fed into the FOURSLIDE tooling area, where the first blank is cut off from the one following. (See Tooling Step #1). After the 6 additional steps shown here, the piece is completed and ejected. SEVEN MODELS of NILSON ribbon metal forming FOURSLIDES are available with various speed ranges between 32 to 204 parts per minute, stock widths up to 3½ inches, and with built-in press sections ranging from 5 to 75 tons capacity.

Many of these production savings can be yours when you consider *every* metal stamping and wire forming job as an opportunity to save time and dollars with a NILSON FOURSLIDE MACHINE.

Remember — it's usually simpler to tool a FOURSLIDE, it's certainly faster, the economy is startling, and you'll do stamping jobs in one operation that you didn't think could be done.



NILSON

A. H. NILSON MACHINE CO.
623 Bridgeport Avenue • Shelton, Conn.

Write today for the NILSON FOURSLIDE Catalog No. 62.

LAMINATING PROCESS SIMPLIFIES TOOLING

Fig. 1. Construction of a large paraboloid reflector of glass cloth and epoxy resin. Each layer of cloth is uniformly coated with the resin formulation so that the next layer to be added will be thoroughly saturated. This is important for strength.

By Benjamin Sokol*

Supervisor, Nonmetallic Section
Manufacturing Research and Processess
Republic Aviation Corp.
Farmingdale, N. Y.

Building a plastics laminate to be a self-restraining unit minimizes tooling required to fabricate a large plastics part. As the resin cures, atmospheric pressure supplies the restraining force. Thus large pressure-applying tools are not needed for fabrication.

HEAT CURING of a large unrestrained laminate usually results in considerable warpage of the finished unit. For this reason large structures that are made to close tolerances are usually cured under pressure to maintain accurate reproduction of the mold. A technique of building laminates developed at Republic Aviation Corp. circumvents the pressure curing requirement by making the laminate a self-restraining unit.

The process was developed for construction of a parabolid radar reflector eight feet in diameter made of glass cloth and epoxy resins, *Fig.* 1. The proces is based on the capability of a laminated part to become a self-restraining unit in conjunction with the mold itself. When cured at room temperature, the laminate forms an air-free, air-tight joint with the mold. In essence, an initial ambient temperature cure makes the laminating resin sufficiently rigid and impermeable so that it acts as its own vacuum bag.

In producing the reflector a zinc chromate paste, which is applied in the radius area between the mold and reflector face around the perimeter, seals the edge. Atmospheric pressure supplies the restraining force which is effective even through oven curing. Molding the laminate in this manner thus eliminates large surface area tooling.

Part Specifications: The reflector unit has to withstand 100-knot winds loads plus a short duration 20 psi load head on. This amounts to a load of nearly 175,000 lb to be transmitted through the

***Senior member ASTME Long Island chapter.**

reflective face, backup structure and mounting surface. Specification for electrical reflection are stringent, as are de-icing qualities and the allowable weight of the unit is limited.

From engineering studies it was concluded that the rear structure of the reflector would have to be made strong enough to carry all of the load while the front reflective face would supply the reflective accuracy and serve to distribute the loads. The load bearing rear structure is prefabricated and post cured. The front reflective face is made by the new laminating process and is bonded to rear structure while on the mold.

The mold for the face, *Fig.* 2, machined of aluminum, is mounted on a specially designed base, leveled to the required water line and checked against lofting templates. Upon checking the mold for the prototype reflector, errors in the mold contour were noted. These errors were not corrected althought they removed as much as 0.010 inch from the available tolerance in some locations.

Fig. 2. After parting agent is applied, the reflective surface of the reflector is aluminum flame sprayed.

Laminate Construction: A steel fence is constructed on the mold water line which forms the perimeter of the reflector. The fence-mold joint is filled with the zinc chromate paste and a parting agent is applied to the surface of the mold. This is followed by a coat of ice-phobic material resistant paint. Metallic aluminum is then flame sprayed onto the prepared mold surface to a thickness of 0.005 to 0.010 inch.

The face skin is built up over the aluminum surface by applying Trulite L-100 epoxy laminating resin and 150/164 glass cloth in successive layers until the desired laminate thickness is achieved. The number of cloth layers varies from five to ten. In structural glass laminates, laps are usually preferred to butts at the cloth joints, but, since it is necessary to hold uniform wall thickness on both face skins, all joints are butted—with care being taken to asure that no two joints are superimposed.

The resin used is a Republic-developed room temperature curring epoxy formulation based on Shell Chemical Co. Epon 820 resin. It is cured with diethylenetriamine.

An interesting sidelight to the laminating technique is the use of nylon flocking to eliminate surface preparation of an unfinished laminate. Quite often, lay-up is interrupted before the full number of glass cloth layers have been applied. In such

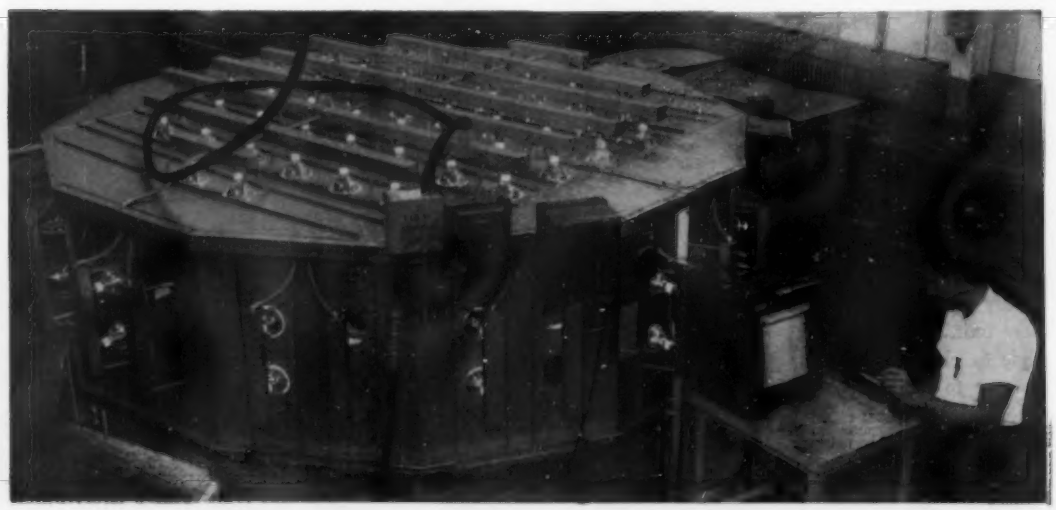


Fig. 3. Radiant heat oven for curing laminates of front reflector face and rear structure. Temperature is recorded continually on six-point recorder.

Fig. 4. Rear structure is built over a mold. Mounting nut plates are fastened in place by drilling through bushings in the mold and tightening with shoulder bolts.

cases, the surface must be roughened by sanding or other means to assure bonding of the fresh cloth and resin. This roughening is particularly necessary on a humid day when a film of diethylenetriamine curing agent exudes to the surface, inhibiting resin bonding.

It has been found that dusting nylon flocking over the entire surface of the wet layup prior to an inactive period permits immediate resumption of laminating without the need for surface sanding. The excess flocking is blown off just before laminating is resumed.

Each layer of cloth is embedded in the resin and thoroughly worked to avoid any possible entrapment of air. When completed, the face laminate is allowed to set for a short time at room temperature. It is then cured in place by encircling the mold with a clam-shell radiant heating oven, *Fig.* 3. The face structure is later trimmed to the fence.

Building the Rear Structure: Upon completion of the rear structure mold, corner radii are filleted and low areas are filled with plaster. The bolt holes and other pick-up points are clay-filled. After the perimeter is lead-taped, the borescope tube mandrel is positioned and parting agent is coated over the mold surface. Center tube and borescope are separately fabricated of epoxy resin and 150/164 glass cloth. Extreme care is taken to tie in the borescope tube accurately after it is located on the mandrel. Additional layers of cloth and resin are applied around the tube where necessary.

Mounting nut plates are fastened in place by backdrilling through previously located bushings in the mold base plate and tightening down with shoulder bolts. Several cast aluminum mounting fittings are bonded in place in a simlar manner. Epoxy-capped aluminum tubes are bonded to the mounting nuts in order to prevent the resin from sticking to the face of the nuts as well as to allow free passage of the bolts for 1 inch beyond the nuts, *Fig.* 4.

The internal stiffening structure consists of radially disposed laminate-foam sandwich ribs, *Fig.* 5, which are taped and bonded in place. These ribs are made up of sheet sandwich material in panels 48 by 54 inches. Panels are fabricated of sandwich layers of Bean "K" woven roving around a core of cellular cellulose acetate with an epoxy resin binder. A slower catalyst than diethylenetriamine is used to allow a longer working period. After the panels are post-cured at 240 F for eight hours, the ribs are cut to loft templates and dry fitted to the rear skin.

The entire rear structure and its mold encircled by the radiant oven, and the laminate is post-cured in place at 150 F for 15 hours followed by 200 F for 24 hours. Although cure may be longer than necessary, experience has indicated that for strength and stability, a long-time high-temperature (200 F) cure is safe and much preferred to an undercured condition.

Tie-down bolts are withdrawn from the mounting face and the rear structure removed from the mold. Three perimeter tooling alignment holes are drilled in the rear structure to mate with holes in the face laminate. After a dry-run fit of rear structure to front face, rib interference points are sanded down until perimeter holes are aligned.

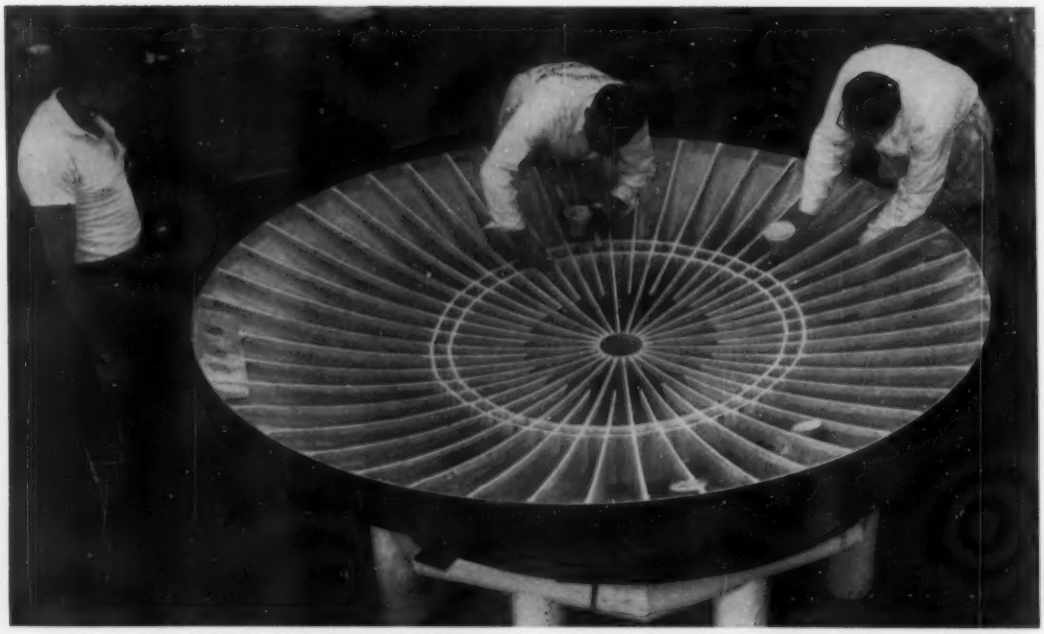


Fig. 5. International stiffening ribs of rear structure are bonded in place with resin. Ribs are made from laminate foam sandwich panels.

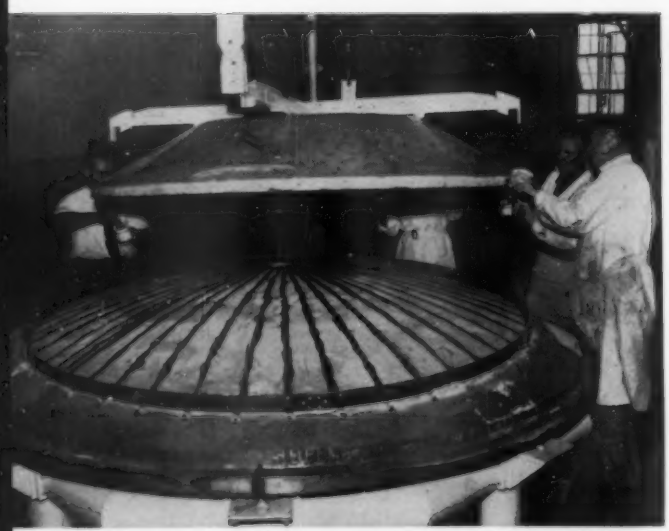


Fig. 6. After epoxy adhesive is applied to the perimeter of the rear structure and ribs have been coated, the reflector is assembled by lowering rear structure over the reflector face still on the mold.

Assembly: The rear of the face laminate is pencil-lined for rib locations and adhesive Epon VI is brushed on to areas to be bonded. The adhesive is liberally applied to all exposed rib and tube edges; rib and tube sides are coated to a distance of 1 inch from the faying surfaces. The rear structure is then inverted so that the epoxy resin adhesive can be applied to the perimeter faying surface.

Final assembly consists of lowering the rear structure onto the front face, *Fig.* 6 and inserting three perimeter alignment pins to align both rear and face structures. The perimeter gap is filled with epoxy-staturated glass tape and rovings while a thixotropic epoxy formulation is used to fair-in the exterior of the perimeter joint. After a room temperature cure, the assembled reflector is removed from the face mold and washed down with solvent.

Inspection: To test the completed prototype reflector for conformity to mold contour, small clay balls were placed at various locations on the aluminum face mold and covered with small squares of waxed paper. When the reflector was lowered onto the face mold, the clay balls were pressed to a finite gap. Upon removal of the reflector, the height of the pressed clay on the mold was recorded relative to the immediately adjacent mold surface.

Inspection revealed that the reflector face was within plus or minus 0.004 inch of the mold except for two small local surface perimeter areas where there was a maximum variation of 0.018 inch. These results were considered excellent since the surface tolerance requirement was plus or minus 0.026 inch over the entire face. The prototype reflector weighed 349 lb, 41 lb less than estimated. Design refinements in production units have permitted a further weight reduction of 20 lb without loss of structural integrity of the reflector.

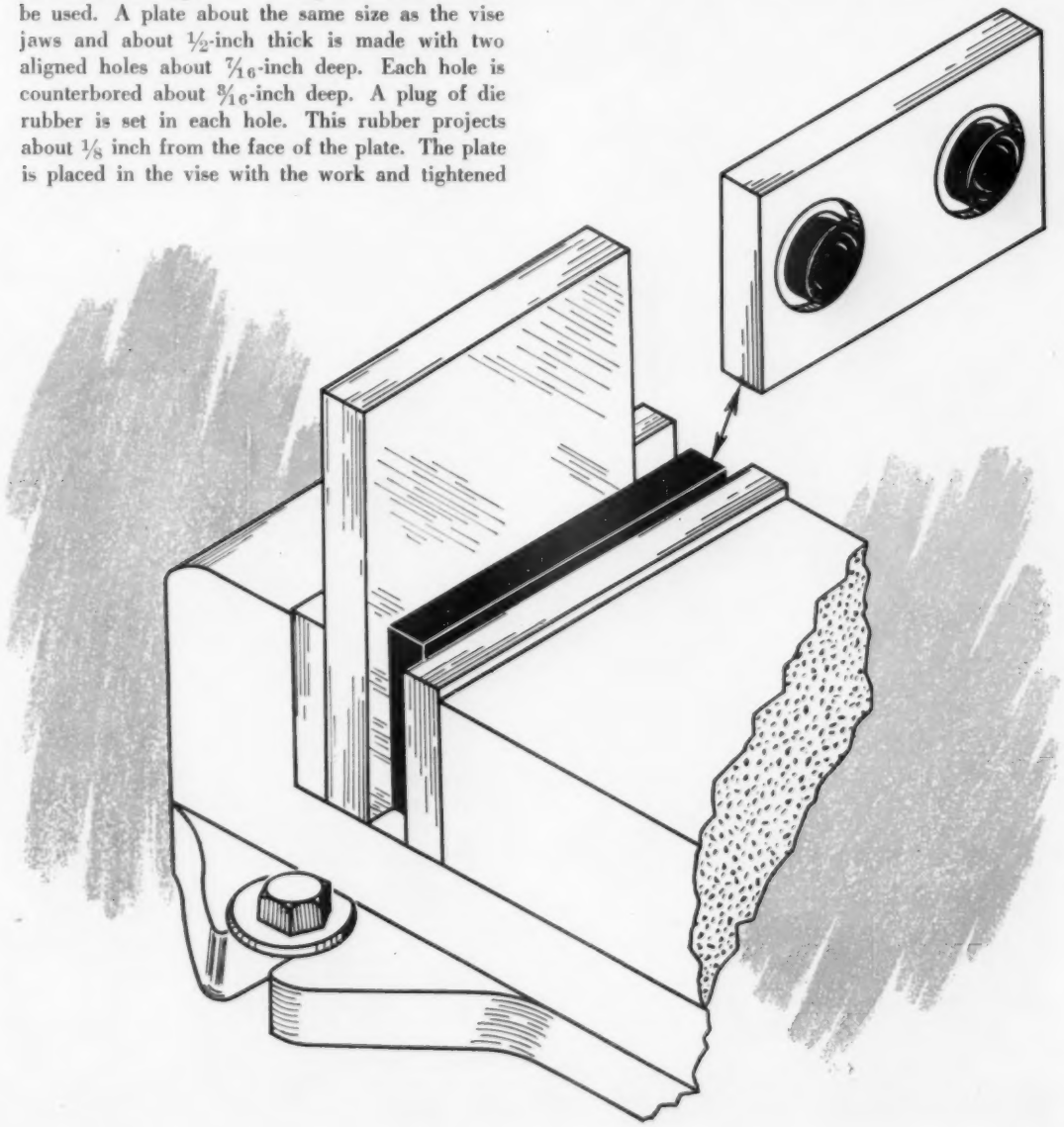
Gadgets

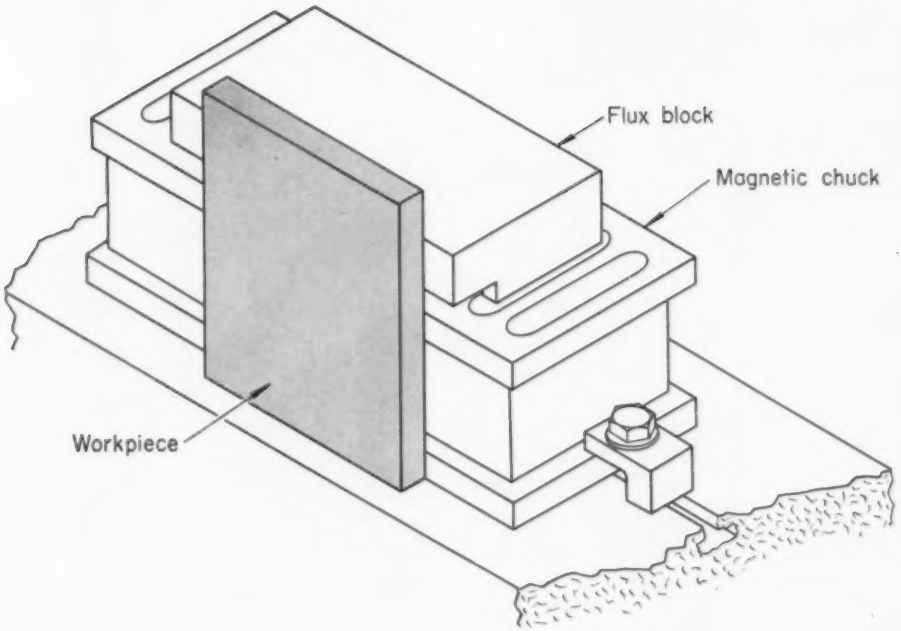
Ingenious Devices And Ideas To Help
The Tool Engineer In His Daily Work

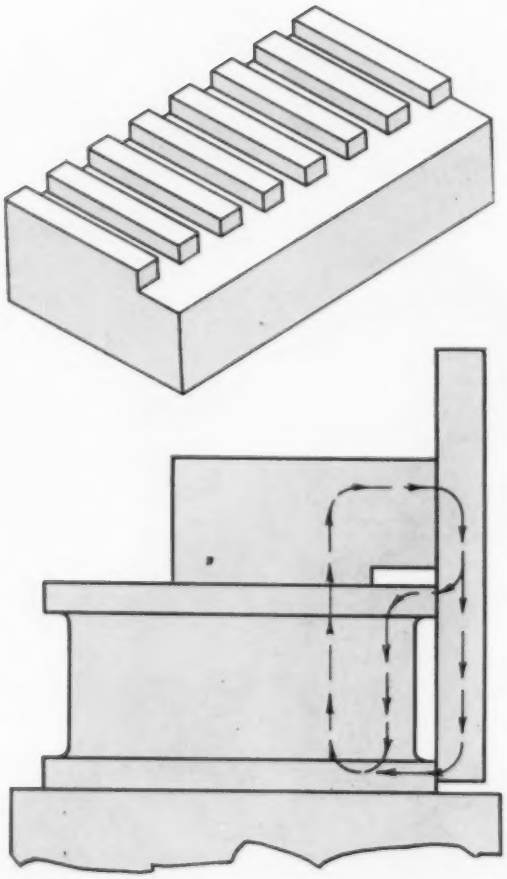
Vise Pads Facilitate Setup

Usual procedure when setting up work in a vise is to tighten the vise lightly and tap the work in position using an indicator or square. It is often difficult to set the vise pressure so that the work can be shifted easily with a light tap. The vise is frequently too loose or too tight. To overcome these disadvantages the vise jaw illustrated can be used. A plate about the same size as the vise jaws and about ½-inch thick is made with two aligned holes about 7/16-inch deep. Each hole is counterbored about 5/16-inch deep. A plug of die rubber is set in each hole. This rubber projects about ⅛ inch from the face of the plate. The plate is placed in the vise with the work and tightened until the rubber is slightly compressed. The work is then tapped into proper position. As the vise is tightened fully, the rubber is squeezed into the counterbore providing a steel-to-steel grip.

Ernest Jones
Bronx, N. Y.







Magnetic Chuck Block

Occasionally a die block is too big to grind to size conveniently before machining the die openings. When the size of a die block exceeds the clearance between the magnetic chuck and the grinding wheel, the gadget illustrated can be used to assist in holding them. A steel block is machined as shown. The projections are spaced so that one projection will lie in the center of each of the poles on the chuck. The ends are cut back so that the contact is entirely within the area of the pole face.

The die block is placed on the table or just above it. The flux block is placed on the chuck surface in contact with the die block. When the chuck is turned on, the die block is held securely. It is best to check to be sure the rear projecting edges of the chuck are parallel and square with the face. If they are not, the chuck can be turned up on edge and ground.

Clint McLaughlin
Rockaway, N. Y.

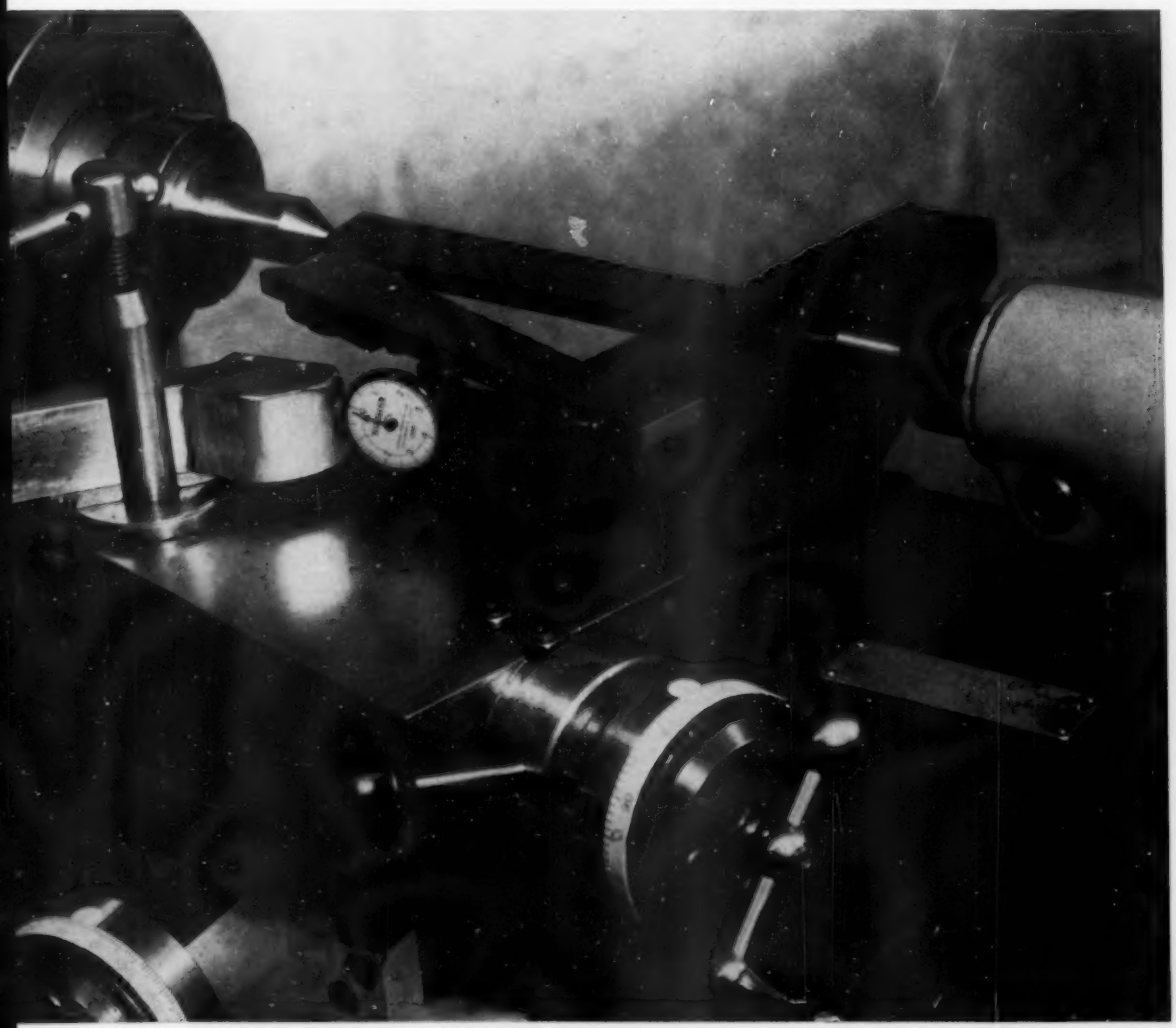
Hinged Sine Bar*

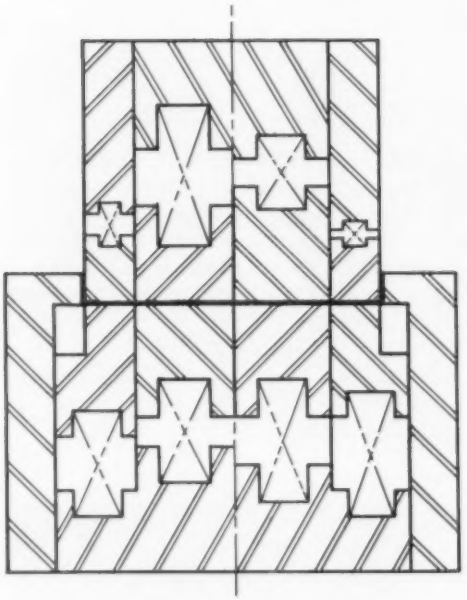
Adding a hinge to a sine bar and otherwise modifying it converts it into a versatile tool with many uses. Made of ground stock, the arms are hinged so that one roll remains in constant contact with the reference surface. Gage blocks stacked under the other roll determine the angular setting. A simple lock prevents undesired movement. Steps machined in the underside of the adjustable arm provide parallel surfaces for clamping of small parts.

A bar, ground parallel and flat, can be attached to the bottom of the reference arm for easy clamping in a vise or on a machine table. Centers in the ends of the reference arm facilitate mounting between centers for precise setting of a lathe compound or checking alignment of a tailstock. The bar can be mounted on a grinder to guide a wheel dresser. Many other uses are possible where angular measuring is required.

Robert E. Daly
San Fernando Valley Chapter

*Gadgets Contest Entry



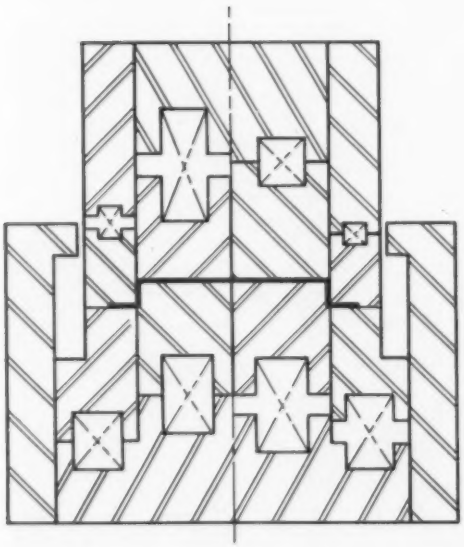


First form

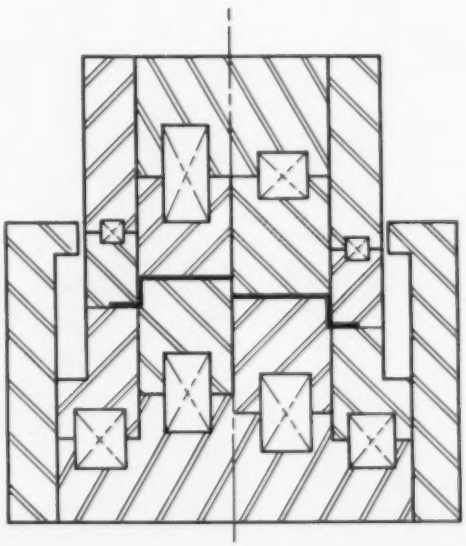
Double Form and Cutoff Die

Difficulties in forming double right-angle bends in stamping are resolved by use of the form and cutoff die illustrated. Utilizing a two-in-one blank to neutralize forming pressures, the die moves the double blank through two forming operations before parting it. The first forming operation bends outside flanges using a segmented punch and pad. As the punch continues its descent into the die, its outer flange sections move past the inner pad, forcing the blank into its second bend. This forming action is performed entirely against spring pressure before shut height has been reached. After the left-hand section of the die pad bottoms, the right-hand section of the punch pad moves past it, parting the panel as shown.

Federico Strasser
Santiago de Chile



Second form



Cutoff

Contributions for these pages describing short cuts for the tool engineer are welcome. Finished drawings are not necessary. Honorariums for accepted articles are sent upon publication.

putting GUN REAMING to work

By Herbert Gregg
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Star Cutter Co.
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Multiple-flute gun reamers have passed the stage of laboratory development and are being successfully applied in many plants. They produce smooth, accurate holes at high production rates.

DURING THE PAST SEVERAL YEARS, production experience has resulted in the development of greatly improved gun reamers. Originally designed with two flutes, gun reamers are now made in four, six, eight, ten and twelve-flute designs. Application of these new designs, *Fig.* 1, has effected savings in machining time and cost, and has improved hole quality as well.

From Paper 267, "Pressure-Coolant Drills and Reamers for Precision Hole Production," presented at the 28th ASTME Annual Meeting. Copies of the complete paper are available for purchase from Society Headquarters.

At first glance, multiple-flute gun reamers look like conventional carbide reamers, There is, however, a considerable difference between the action of the two types of reamers. In gun reamers, *Fig.* 2, the coolant flows under pressure through the tubular steel body of the tool and through angular holes at the bottom of the flutes in the molded solid carbide blank. Chips are flushed out ahead of the reamer and are thus prevented from wedging between the hole surface and the cutting edges. A guide bushing is used with the reamer in all machine tool applications.

Research Program: Initial success with two-flute gun reamers led to the question: "How many flutes are required for greatest efficiency?" To find the answer, tests were made with automotive engine rocker arms. Hardness of the nodular-iron castings was 20-33 Rc. The castings had a drilled

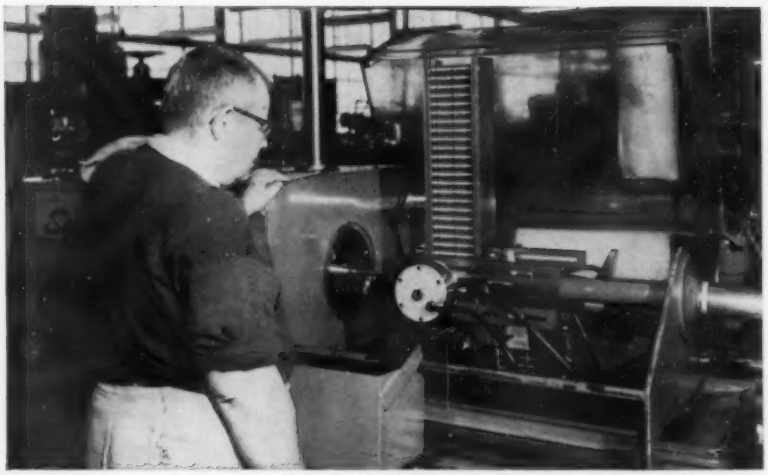


Fig. 1. Horizontal boring machine equipped with a magazine for gun drilling and reaming center holes of graphitic steel parts.

hole in which 0.045 inch of stock was left for gun reaming. Finish size was 0.843 inch, ±0.0005 inch. A surface finish of less than 50 microinch, rms, was required.

Several types of test tools were made to carry out the program. These included two-flute, four-flute and six-flute reamers. Both straight-flute and spiral-flute reamers were tested.

All of these tools held hole size within specified limits and roundness within 0.0002 inch. Surface finishes improved with the number of flutes. There was no difference in the results obtained with straight-flute and spiral-flute designs. The tests also showed that a tool end angle of 60 deg was desirable and that optimum oil pressure was 150 psi.

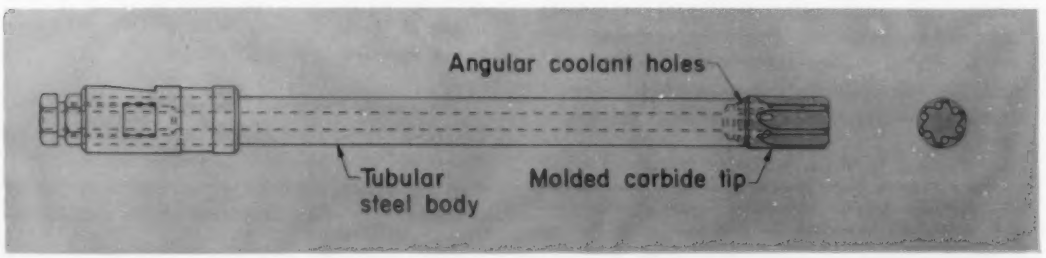
These results led to the design of eight-flute and ten-flute tools for additional tests. One thousand parts, some having holes with as much as 0.030-inch eccentricity, were reamed with a ten-flute tool. Reamer feed was eight ipm and speed was 1200 rpm. All of the holes reamed in the tests were within tolerance and a 20-25 microinch finish was achieved. This confirmed the desirability of multiple-flute designs.

The number of flutes recommended in a gun reamer for a specific application is limited, of course, by the amount of area provided for coolant to force chips ahead of the tool. In the case of a cored hole, the size of the core and the amount of core shift also have to be considered.

Multidiameter Reamers: One of the more interesting developments in gun reaming is a multidiameter or step-tool design. To date, these tools have been mostly two-flute types, with two and three steps. Such reamers are being extensively applied for the reaming—to finish size—of cored holes in die-cast aluminum valve bodies. In die-cast parts there is little likelihood of core shift and it is entirely feasible to finish ream the cored hole to size in one operation. With cast-iron parts, on the other hand, there is often considerable shifting of the cores, and it may not be possible to ream to size in one operation. A good method is to rough core ream with a two-flute gun reamer and then finish-ream to the stepped-hole size with a multiple-flute gun reamer.

Applications: A typical gun-reaming application is shown in *Fig.* 3. The part is a cast-iron automotive engine water-pump body. The operation is carried out on the last machining station of a Kingsbury rotary drilling machine. Hole length is 2½ inches; finish hole size is 1.179 inch,

Fig. 2. Straight-flute gun reamer. Coolant flows through reamer body, passes out through holes in the carbide tip, flushing chips through the hole.



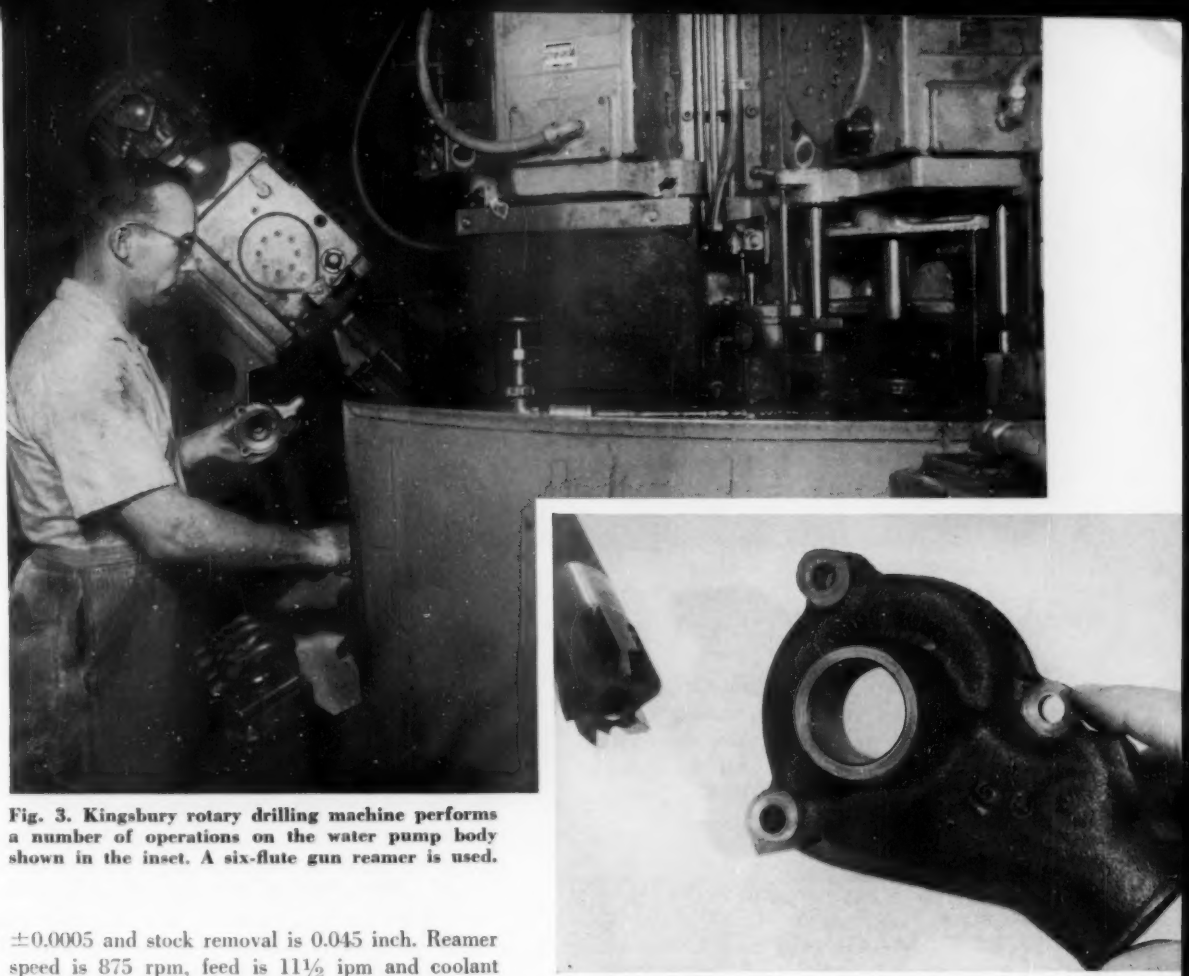


Fig. 3. Kingsbury rotary drilling machine performs a number of operations on the water pump body shown in the inset. A six-flute gun reamer is used.

±0.0005 and stock removal is 0.045 inch. Reamer speed is 875 rpm, feed is 11½ ipm and coolant pressure is 120 psi. Ninety-microinch surface finishes are obtained.

Gun reamers are also used for machining steel. The center holes of the graphitic steel parts being magazine-fed into the horizontal boring machine shown in *Fig.* 1 are reamed with two-flute gun reamers. The holes are first drilled with a single-flute gun drill (or twist-drilled in the larger sizes) and then reamed with a two-flute gun reamer. Both operations are carried out on the horizontal boring machine. Part and operating data are shown in the accompanying table.

A 12-flute gun reamer is used to counterbore tubular steel conveyor rolls, *Fig.* 4. The roll is reamed to finish size from the as-extruded condition. Hole length is 1⅜ inch. Hole size is 3.105 inch, ±0.001. Stock removal is 0.083 to 0.145 inch. Speed is 425 rpm; feed is 10 ipm. Coolant pressure is 200 psi.

The examples illustrate the versatility and speed of gun reaming. The ability of gun reamers to finish both long and short holes in various materials with high precision is unsurpassed.

Data for Gun Reaming a Graphitic Iron Part

	Hole 1	Hole 2	Hole 3	Hole 4
Stock removal, inch	0.025	0.032	0.023	0.068
Finish hole size, inch	0.306	0.625	0.241	0.427
Hole tolerance, inch	+0.001	+0.001	+0.001	+0.001
Hole length, inch	2⅜	3 29/32	2¾	5 17/32
Surface finish, microinch	40-50	30-60	80	30-80
Reamer speed, rpm	2200	1300	3000	1600
Reamer feed, ipm	4	6	4	4
Coolant pressure, psi	450	450	500	450

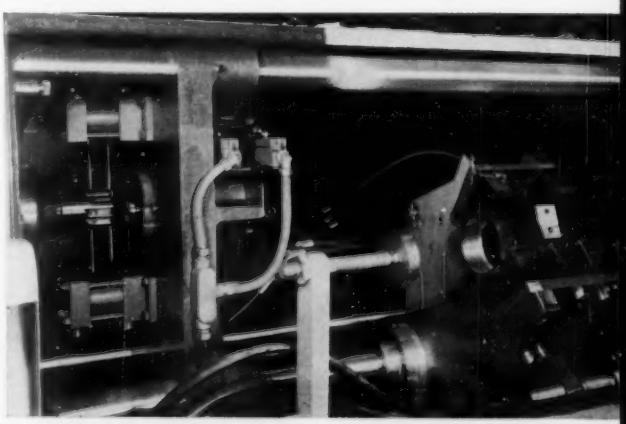


Fig. 4. Hill high-speed drilling machine set up to counterbore steel tubing to finish size for conveyor rolls. A 3.105-inch diameter gun reamer is used.

how to apply
PNEUMATIC POWER
Part 1—Some Basic Circuits

Air cylinders and air motors provide efficient and reliable actuation for fixtures, machines, presses and automation equipment. This is the first of a series of three articles that cover the best methods for applying pneumatic power.

TOOL AND MANUFACTURING ENGINEERS are responsible for planning production lines. Whatever the type of product, much of their effort is concentrated on obtaining desired motions—movements of machine members, movements of tools, movements of workpieces. Most of these movements are either linear — as in the travel of a drilling head — or rotary, as in the case of an indexing table. Actuation can be furnished by muscle power, electric power or by fluid power—pneumatic and hydraulic. All of these power systems have their place and the selection of a power system for a specific application depends on the relative cost, amount of power required, the space available for the actuating means, speed requirements, maintenance considerations and environment.

The relative simplicity, compactness, versatility and low initial cost of pneumatic power systems make them a frequent choice. Rotary motion is produced by air motors: linear motion by air cylinders. This motion is controlled by valves which, with air lines, filters and lubricators make up the pneumatic power circuit.

Successful application of pneumatic power depends on good circuit design. Despite their complex appearance, all pneumatic circuits are essentially simple. In fact, the simpler the circuit, the better the results. A number of highly satisfactory circuits are illustrated in this article.

Basic Design Considerations: Circuit design starts with the selection of the actuator. In the case of a cylinder, the amount of power that can be produced depends on the area of the cylinder bore multiplied by the available air line pressure. In most plants, air line pressure is from 80 to 100 psi.

Friction caused by piston and rod seals usually reduces the power output of the cylinder by 5 percent. If the return stroke of a piston is used as the power stroke, the cross sectional area of the piston rod must be deducted from the area of the cylinder bore. This is especially important to remember when cylinders with large-diameter piston rods are used.

Operator safety is an important consideration in circuit design. The circuit designer can take advantage of many possibilities to provide safety without affecting the performance of the power system as a whole. In one press application, for example, it may be desirable for the operator to have both hands free to position or handle the workpiece while the press ram is moving. In another application, it may be necessary to design a circuit that requires the operator to keep both hands on the controls when the ram is moving.

Preventing possible damage to workpieces is another important design consideration. In circuits which perform a number of automatic operations in sequence, manual controls for certain portions of the system are often used to facilitate setup. Unless interlocks are provided, damage to the workpiece or the machine itself is possible. On a transfer type machine, for example, controls should be provided to prevent a machining head from feeding when a transfer device is directly under the head.

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By H. L. Stewart*
Logansport, Ind.

While providing such interlocks seems elementary, they are often forgotten.

Even the best-designed systems fail if the air supply is not filtered and lubricated. Lack of lubrication increases friction and causes rapid wear of valves and cylinders, piston and rod packings, and metal surfaces. Lack of lubrication also causes sluggish action of valves and cylinders. Use of improper lubricants may cause seals to swell or shrink, resulting in either increased friction or air leakage. If filters are omitted, small particles of scale and dirt become embedded in packings and cause scoring of cylinder walls, valve liners and other precision components. This can, of course, result in malfunctions in service.

Air pressure should be controlled by a pressure regulating valve. Unless air pressure is kept at a constant level, pressure surges—which may affect the performance or reliability of the system—result.

Staking Circuit: The circuit shown in *Fig.* 1 incorporates all of the recommendations that have been discussed. Air enters the system through a filter, pressure regulator and lubricator, and operator safety is assured by interlocks. This type of circuit is used for shearing, punching, coining, assembly operations and staking, where fast approach and rapid withdrawal of the tool are required.

The circuit functions as follows: the operator drops the workpiece (a loose assembly of several parts) into an air-actuated collet and momentarily depresses pushbutton *A* on the control panel. This energizes solenoid *E*, which shifts the spool of four-way, two-position valve *C*. Air is directed from the inlet port to port 2, then to port *X* of clamp cylinder *T*. The piston retracts and the collet locks the workpiece in position. The operator then depresses buttons *G* and *H*, which in turn energize solenoids *I* and *K* of three-way valves *L* and *N*. Air flows through valve *L* and then through cutout valve *M*. From *M* it passes into *N* and into the pilot connection of four-way spring-offset valve *P*. The air pressure shifts the spool of valve *P* and air is directed to port *Q* of the staking cylinder *AA*. This piston advances rapidly and the staking tool performs the operation.

If the operator removes either hand from the controls, the piston will immediately retract. He cannot tie down either control since the cutout valve will not function unless a fixed quantity of air is

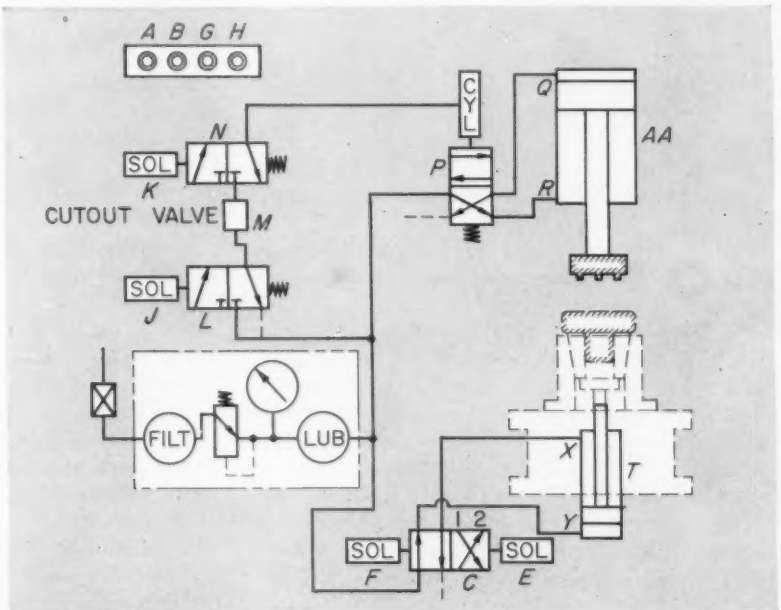


Fig. 1. Basic circuit for staking and similar operations where fast approach and rapid withdrawal is required.

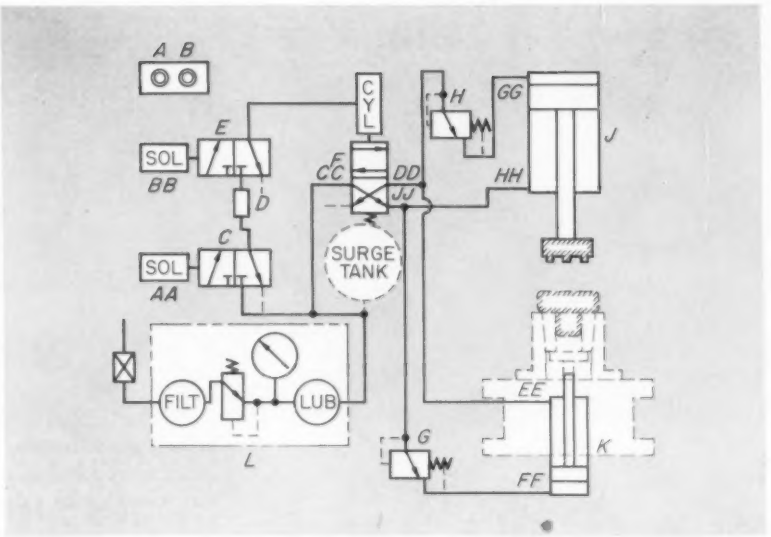
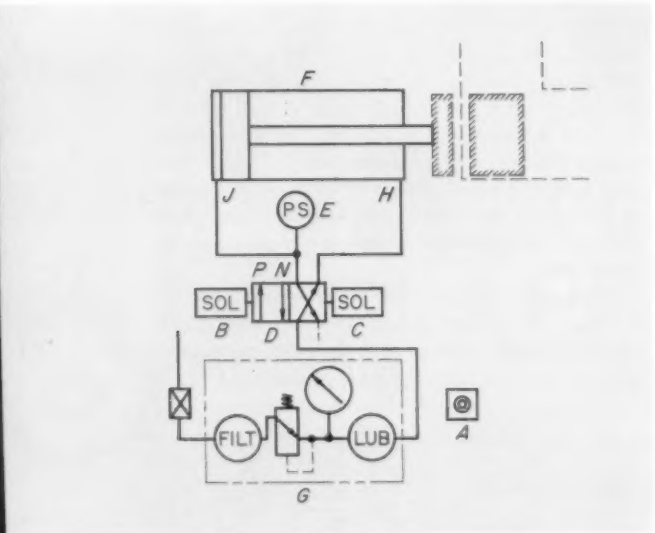


Fig. 2. The basic circuit shown in *Fig.* 1 can be modified to eliminate two of the control buttons. A surge tank can be added to produce a hammer-like blow of the piston.

Fig. 3. (below) In this circuit, a pressure switch causes the piston to retract if excessive resistance is met. This protects the tool and the machine.



passed through it on each cycle. When the given volume of air has passed through the cutout valve, it stops any additional air from passing until the upstream air is exhausted. This air must be exhausted by some other means before another cycle can start.

To complete the work cycle, the operator releases his hands from controls *G* and *H* and the piston retracts. He then momentarily depresses pushbutton *B*, which energizes solenoid *F* and the spool of valve *C* is shifted, directing air pressure to port *Y* of cylinder *T*. Then the piston moves forward and the workpiece is released by the collet.

Eliminating one four-way valve and adding two sequence valves as shown in *Fig.* 2, removes the need for two of the control buttons. In this circuit the operator depresses buttons *A* and *B*, which in turn energizes solenoids *AA* and *BB* of valves *C* and *E* respectively. This causes air to flow through valves *C*, *D* and *E* and on to the pilot connection of four-way spring-offset valve *F*. The spool of valve *F* is shifted against the spring pressure. Inlet *CC* is then connected to cylinder port *DD*, air flows to port *EE* of cylinder *K* and the piston is forced to retract, locking the workpiece in the collet. When air pressure builds up, sequence valve *H* opens, air flows to port *GG* of cylinder *J* and the staking piston advances rapidly to the work.

If the operator removes either hand from the pushbuttons, the spool in valve *F* shifts to its original position and air is directed from *CC* to *JJ*, then to port *HH* of cylinder *J*. The piston retracts rapidly. At the retracted position, air pressure opens sequence valve *G* and air flows into port *FF* of cylinder *K*. The piston advances, opening the collet and releasing the workpiece.

If there is need to change the staking pressure due to a difference in the density of the material or wear on the staking tool, the operator needs only to change the pressure setting on the regulating valve in panel *L*.

On applications where it is desirable to produce speeds in excess of what can be produced by the normal volume of air passing through the lines, the addition of a surge tank will produce the required hammer-like blow. These surge tanks are easily constructed from a section of pipe threaded on both ends and capped with two pipe caps. The tank should have a volume two to three times that of the cylinder.

When the surge tank is used it is recommended that the cylinders be cushioned on the end that is not performing the work. In the case shown in *Fig.*

2, it would be on the return stroke of cylinder *J* and the outstroke of cylinder *K*. This minimizes shock when the pistons contact the cylinder covers.

In circuits which are to be located in hazardous atmospheres, it is well to eliminate electrical controls and in their place use manually actuated pilot controls such as three-way spring-offset valves. In *Fig.* 2, these valves could be substituted for valves *C* and *E*. If any of the controls are located in extremely hot areas, provisions should be made to protect them from direct hot blasts. If the ambient temperature is in excess of 130 F, all of the circuit components should be equipped with high-temperature packing to prevent failure.

Safety Circuit: In an application where it is vital to protect the tool, the workpiece and the machine, the basic circuit shown in *Fig.* 3 has many uses. In this circuit, when control *A* is momentarily depressed, solenoid *B* is energized and the spool of valve *D* is actuated, causing air to flow to port *P* of valve *D*, then on to port *J* of cylinder *F*, and the piston advances. If undue resistance is met by the piston, the line pressure builds up. The contacts in pressure switch *E* then close, solenoid *C* is energized and the valve spool is shifted to its original position. Then air is directed to port *N* of valve *D*, then on to port *H* of cylinder *F* and the piston retracts rapidly. The contacts of the pressure switch can be set for various operating pressures as required by the application.

Flow Control: In applications which require the tool to be fed ino the workpiece, then rapidly retracted, the designer has some latitude in making his selection of a cylinder. If the feed need not be highly accurate, a pneumatic cylinder can be used in conjunction with a flow control. Where the feed must be accurate and slow, the use of an air-hydraulic cylinder is recommended.

The flow control should always control the air as it is exhausted from the cylinder. Too often the flow control is placed so that the intake air to the cylinder is controlled. As a result, the cylinder piston moves with a jerky action. In instances where feed is to be provided in both directions some designers locate the flow control in the exhaust line of the four-way control. This often causes valve malfunctions, especially solenoid-actuated four-way valves with stem packings. The friction created cannot be overcome by the solenoids and they will burn out.

Cut-Off Circuit: The circuit shown in *Fig.* 4 has many possible applications, some of which are forming, cut-off, testing and machining. In cut-off applications, the operator drops the workpiece in the clamping fixture and momentarily depresses pushbutton *Z*. This energizes solenoid *X* of valve *B*, shifting the spool, and air is directed to port *R* and on to port *L* of clamp cylinder *F* and port *N* of clamp cylinder *G*. Pistons of these cylinders advance and clamp the workpiece in the fixture.

Air pressure then builds up and opens sequence valve *D*. Air flows to the blind end of air-hydraulic cylinder *E*. The control of the movement of the piston of cylinder *E* is accomplished by the closed hydraulic system at the front end of the cylinder. Valve *H* has a variable orifice and regulates the speed of the piston.

As oil is forced from port *BB* it passes through valve *H* and into port *AA*. Since the diameter of

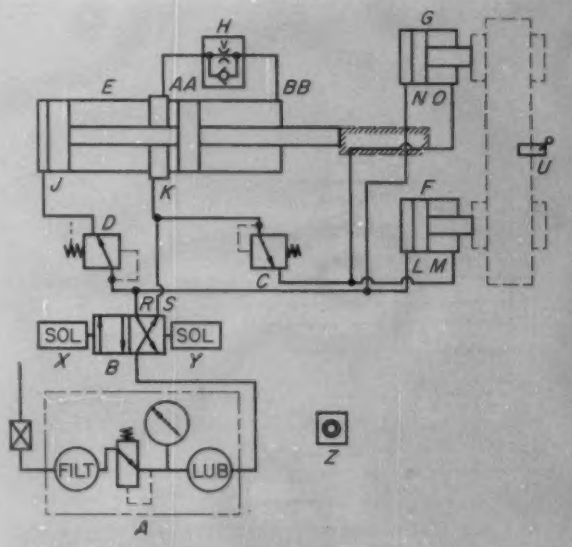


Fig. 4. Circuit for forming, cut-off, testing and machining operations.

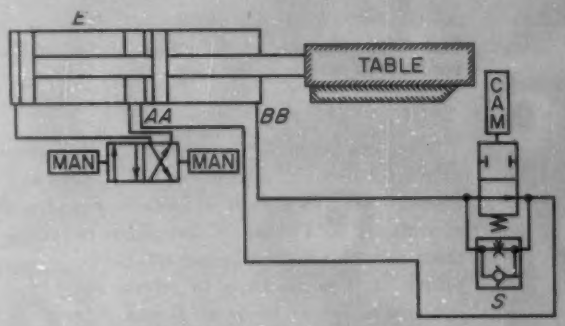


Fig. 5. In this circuit, the tool can approach the workpiece rapidly, move at a controlled rate while work is being performed, then retract rapidly.

the piston rod on the back side of the oil piston is the same as the one on the front side, there is no need for a reservoir. When the closed hydraulic system is filled with oil, smooth, even feed is assured until the packings begin to wear and air enters the oil chamber. To reduce the possibility of air entering the oil chamber the use of an oil filler that acts as a make-up tank is advisable.

The cylinder advances the saw through the workpiece at controlled feed until the slide on the saw guide trips limit switch *U*. This energizes solenoid *Y* of valve *B*, the spool shifts back to its original position, and air flows to port *S* and on to port *K*. The piston of cylinder *E* is rapidly retracted due to oil flowing through the free flow section of valve *H*.

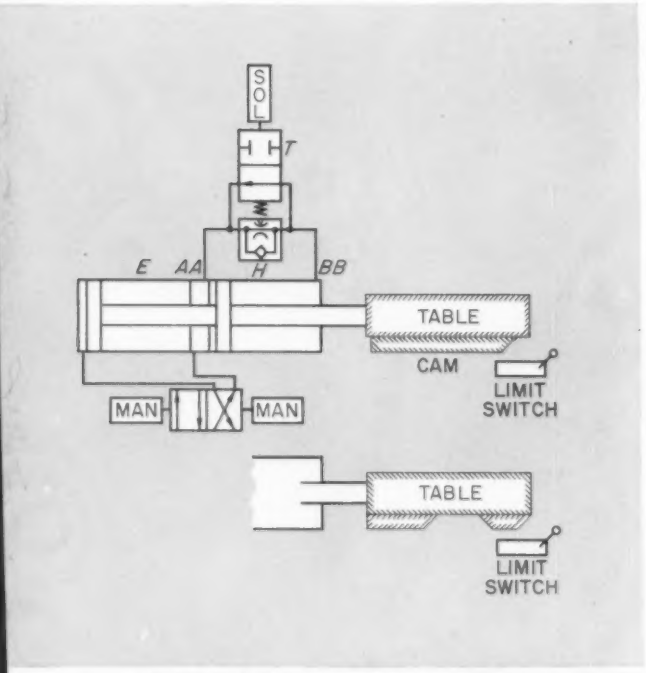


Fig. 6. Modification of the circuit shown in *Fig.* 5 permits fast return of the piston.

When the piston of cylinder *E* is fully retracted, pressure builds up, sequence valve *C* opens and air pressure flows to port *M* of cylinder *F* and port *O* of cylinder *G*. Pistons of the clamp cylinders retract, releasing the workpiece and the cycle is completed. If it is desirable to retract the piston of cylinder *G* before those of *E* and *F*, another sequence valve can be added to the circuit.

If it is required that the tool approach the workpiece at a rapid rate, move at a controlled feed while work is being performed and then be retracted at a rapid rate, a circuit similar to that shown in *Fig.* 4 gives good results. In the line between *AA* and *BB*, changes can be made, as shown in *Fig.* 5. In *Fig.* 5, the flow control valve *H* is replaced with a cam-operated flow control valve *S*. As the piston of cylinder *E* rapidly advances, a cam on the machine table depresses roller on valve *S*, which closes the through passage. Oil must flow through the variable orifice as long as the roller is depressed on the advance stroke. When piston reaches the end of its stroke and is reversed, the oil flows freely through valve *S*, since the check is unseated even though the roller is depressed.

In *Fig.* 6, valve *T* is added to the original cylinder. This valve is a solenoid-actuated normally open two-way valve. Whenever the limit switch is actuated, the solenoid closes the internal passage in the valve and the oil must flow through valve *H*. For fast return of the piston, oil flows freely through the check valve *H*.

To obtain an action of rapid approach, feed, skip, feed, and rapid retraction it is usually desirable to use an air-hydraulic cylinder. The circuit shown in *Figs.* 5 and 6 can be used. On the machine table would be a cam having two lobes as shown in *Fig.* 7. Each time the lobe depresses the cam roller or limit switch roller, feed takes place and each time the roller is released the cylinder piston rapidly advances. Where work is being done intermittently, such an arrangement speeds up the operation and saves considerable time. The piston will retract rapidly at the end of the stroke since oil flows freely through the open check.

Machining Circuit: For grinding, shaving, sawing or planing applications, it is desirable to rapidly advance the tool, reciprocate it a number of times on a short stroke, then retract it to the starting position. A suitable circuit is shown in *Fig.* 7. The operation is accomplished by the use of pilot-operated controls, which are actuated by two-way pilot valves. The same results can be obtained by using solenoid-operated controls and limit switches.

In this circuit, the operator places the workpiece in the clamping device and momentarily depresses foot pedal of four-way latch type foot-valve 8. Air is directed to the blind end of clamp cylinder 9 and the piston moves the clamp forward, locking the workpiece in the clamping device. In setting up the tool, the operator momentarily depresses the button on two-way, two-position spring off-set valve 7, bleeding air from cylinder *B* of bleeder pilot-operated four-way, two-position valve 2. The spool of this valve shifts and air is directed to the blind end of work cylinder 3. The piston of this cylinder advances rapidly until a cam on the piston rod contacts the cam roller of two-way, two-position spring off-set valve 6.

When the cam roller is depressed, air is bled from the line between cylinder *A* of valve 2 and

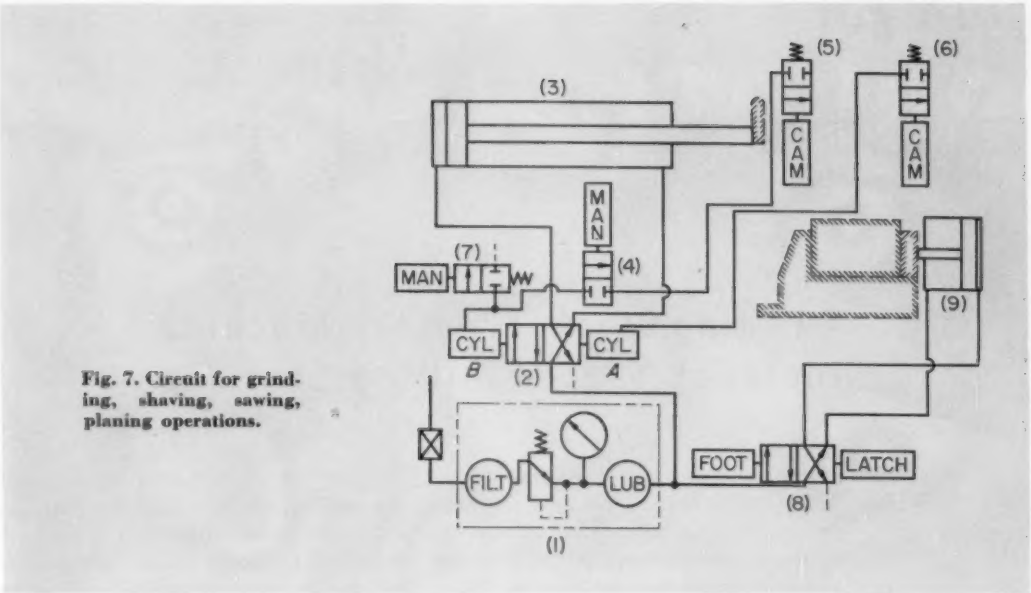


Fig. 7. Circuit for grinding, shaving, sawing, planing operations.

valve 6 and the spool of valve 2 returns to its original position. Air is directed to the rod end of cylinder 3 and the piston is rapidly returned.

After any needed adjustments are made, the operator is now ready to set up the reciprocation cycle. He shifts the actuator on two-way valve 4, opening the line between cylinder *B* of valve 2 and valve 5. Next he momentarily depresses the button on valve 7, allowing air to bleed off from cylinder *B* of valve 2. The spool shifts, directing air pressure to the blind end of cylinder 3 and the piston moves forward until the roller on valve 6 is depressed.

The piston of cylinder 3 retracts until the cam of valve 5 is depressed. This bleeds air from cylinder *B* of valve 2 and the spool shifts, directing air pressure to the blind end of cylinder 3. The reciprocation will continue until operator closes valve 4. When the cam on the piston rod of cylinder 3 rides over and depresses the roller of valve 5 no actuation will take place and the piston will retract to the end of its stroke. The operator again depresses the foot pedal of valve 8 and air pressure is directed to the rod end of the clamp cylinder and the workpiece is released.

By the proper selection of valving the designer will be able to effect many variations in movements of the tool actuating cylinder. The designer should make all circuits as simple as possible, eliminating any unnecessary valving. This will pay dividends.

"Discontented" Engineers Most Creative

Creative effort, free of the "strait-jacket of organizational conformity" is one of the keys to progress, Paul C. Ackerman, vice president-engineering, Chrysler Corp., told the June graduating class of Lawrence Institute of Technology. Stating that no group or organization is better than its best individuals, he said:

"In any endeavor, progress can be measured in direct proportion to the intellectual freedom of action given to the individual members of an organization. The creative individual . . . is indispensable."

Ackerman challenged the group to work hard and continuously toward a definite goal, adopt an attitude of disciplined direction, establish a standard of excellence and be guided by a sense of duty and obligation. He recommended an attitude of discontentment, saying, ". . . it will be discontented engineers who find the better ways (of creating)."

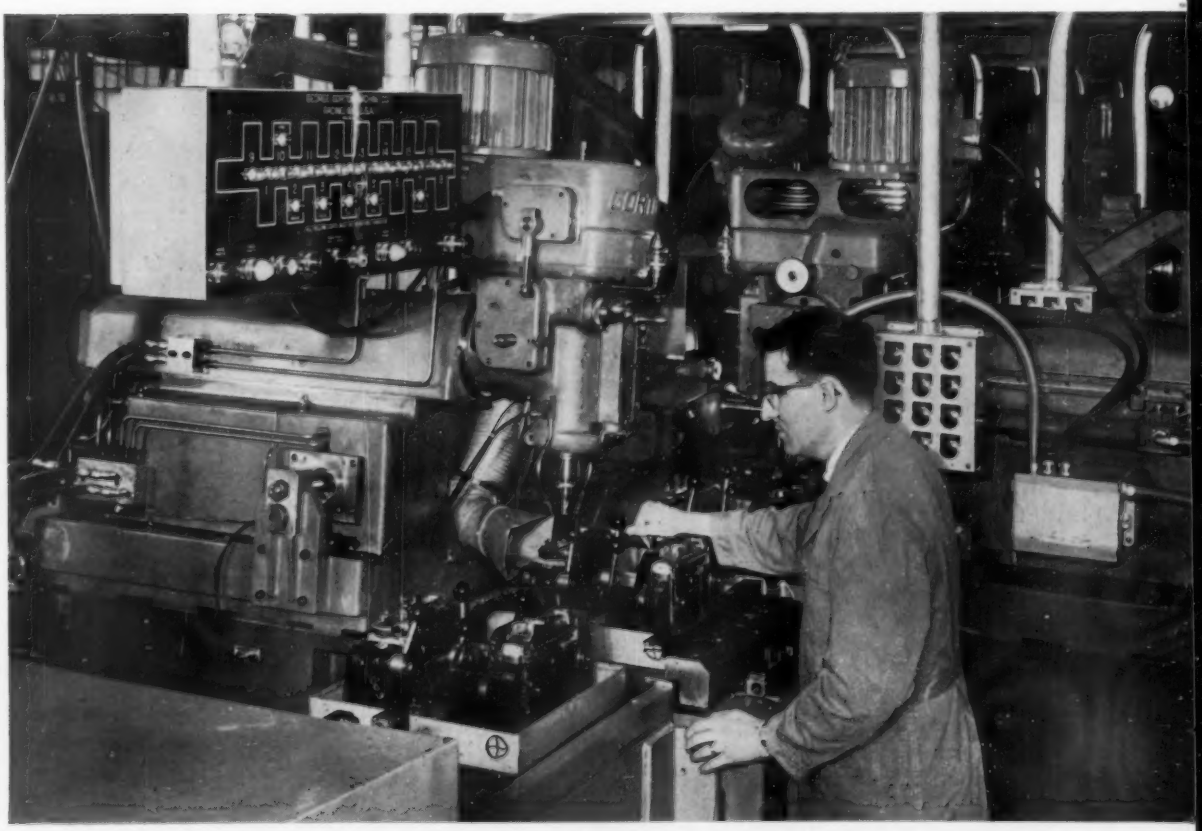
He also pointed out that an open, exploring mind is essential in engineering, and that growth in maturity stems from learning to recover quickly from disappointment and rising above past mistakes. He added that when you believe in your ideas and succeed, then your success in uniquely your own—and that both kinds of experiences are needed to develop full capabilities.

designed for

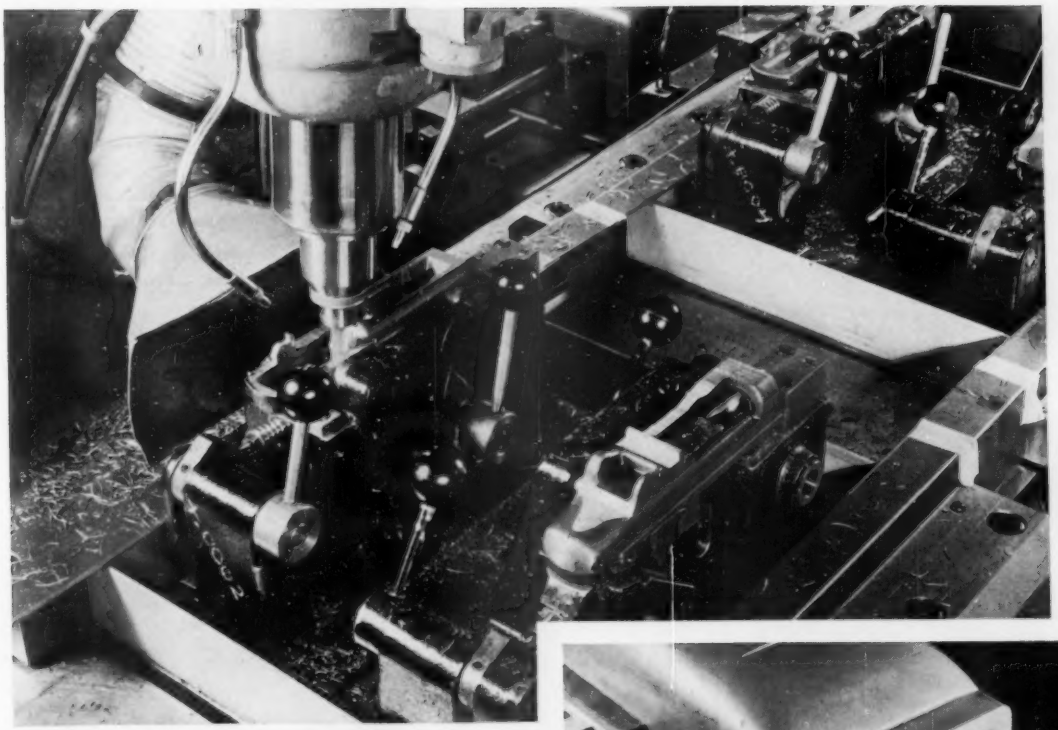
PRODUCTION

Building-Block Transfer Machine Includes Tracer-Milling Stations

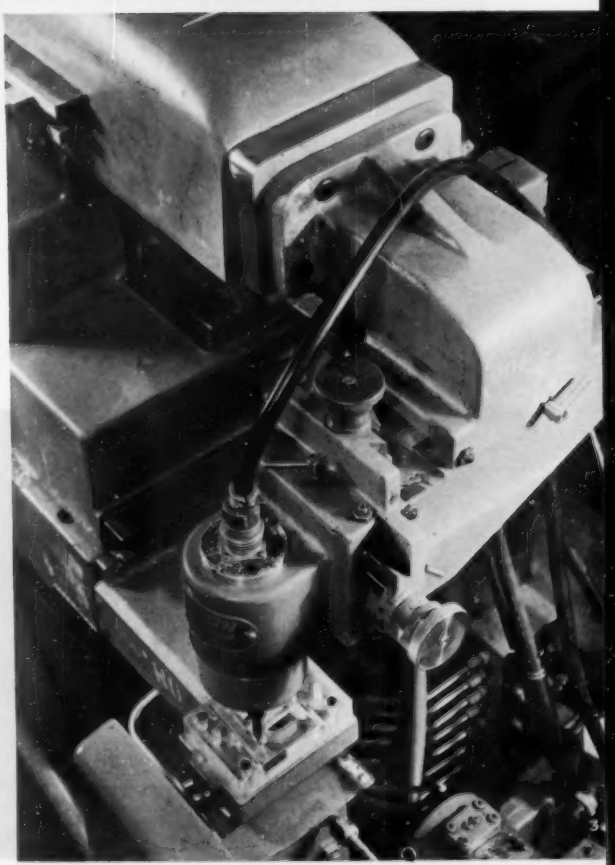
Utilization of standard machine components for a 16-station transfer machine substantially lowered design and build costs for The George Gorton Machine Co. The machine, which performs milling and drilling operations on multiple surfaces of automatic rifle receivers, includes stations for vertical, horizontal and angular milling, undercutting, drilling, and automatic tracer-controlled profiling and duplicating. Planned production is 45 seconds per part. Indexing time is 3 seconds.



OPERATOR'S STATION for building-block transfer machine. Indicator lights show the operating status of each machine station.



TWIN-FIXTURE platen arrangement on building-block transfer machine. The part in the near fixture has just been loaded for the pass through stations one through eight. The part in the far fixture is in operation at station nine. The conveyor platen is individually located at each machine station and locked in position hydraulically.



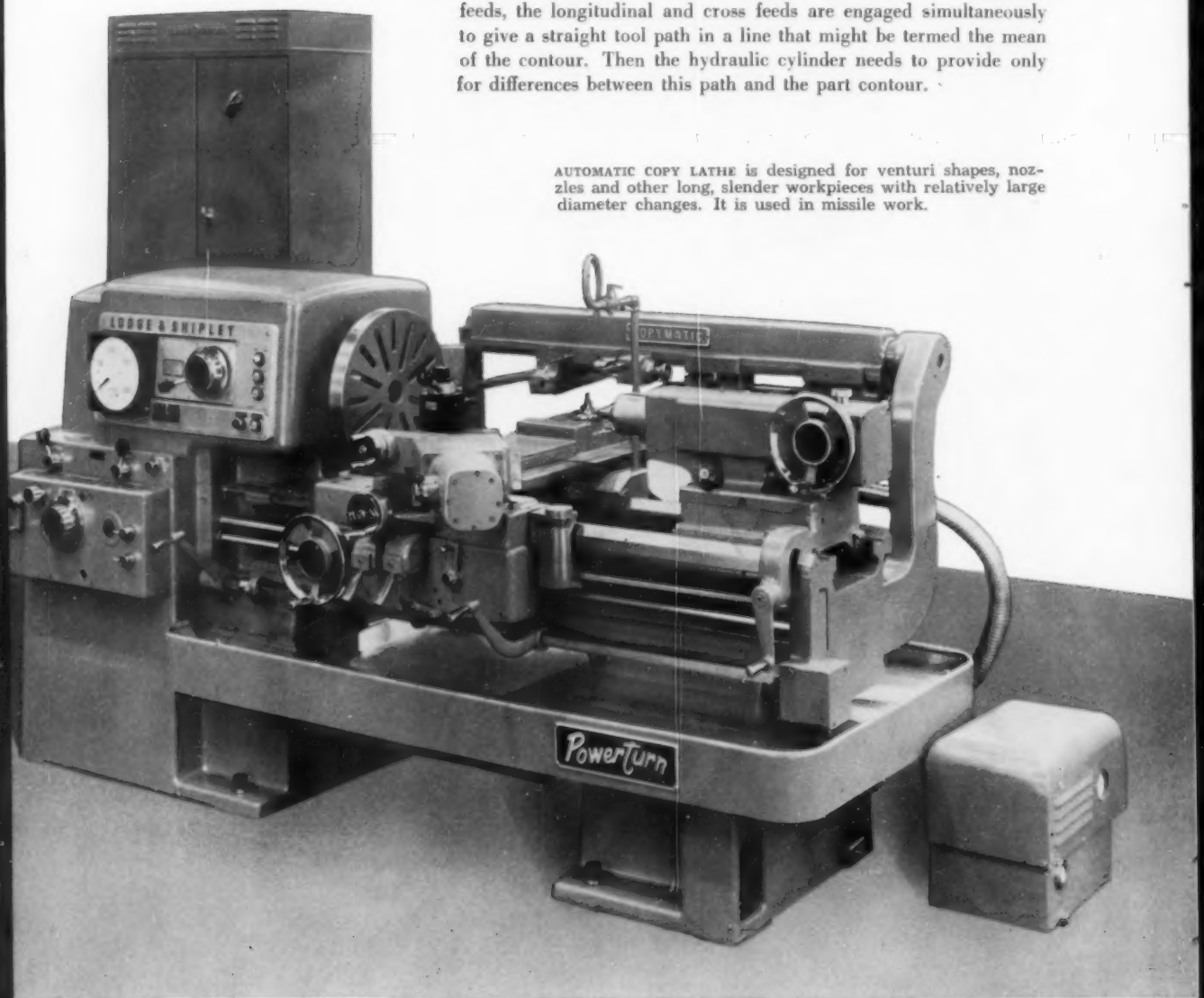
ELECTRIC-HYDRAULIC 360-degree tracer system is utilized in station seven of building-block transfer machine to mill the sight base section of the automatic rifle receiver. The feed rate of the operation is increased or decreased through the use of an in-cycle feed regulator built into the master template. Through this control, the feed rate is slowed in sharp corners and increased on straight cuts and traverse motions. The tracer head has micrometer adjustments in three directions. The template platform is mounted to the slide.

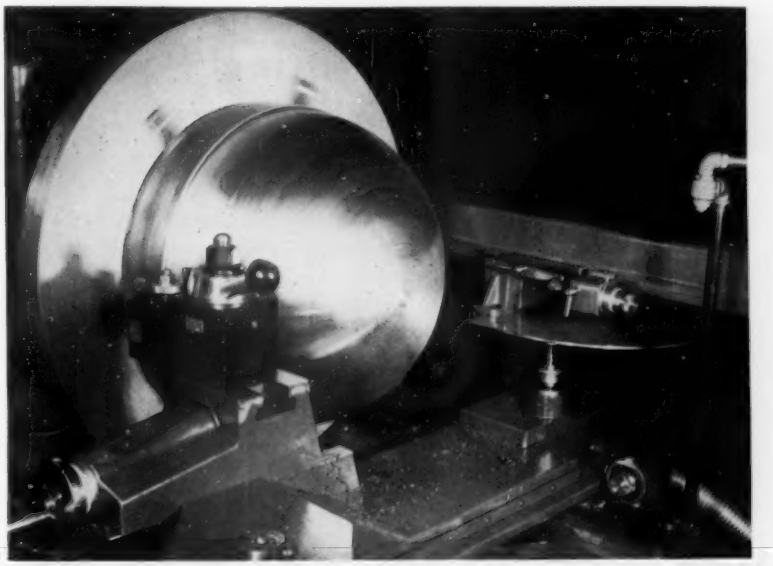
Constant Cutting Speed Lathe Eliminates Speed Control Cams

Constant cutting speed, regardless of contours, is provided by this Lodge & Shipley Co. copying lathe. The lathe headstock is equipped with a 24-speed transmission plus a variable-speed drive that permits infinitely variable control of each speed. In automatic operation, the operator can manually trim the spindle speed.

Use of combined feeds makes possible machining capacities substantially greater than on conventional tracer lathes. In combined feeds, the longitudinal and cross feeds are engaged simultaneously to give a straight tool path in a line that might be termed the mean of the contour. Then the hydraulic cylinder needs to provide only for differences between this path and the part contour.

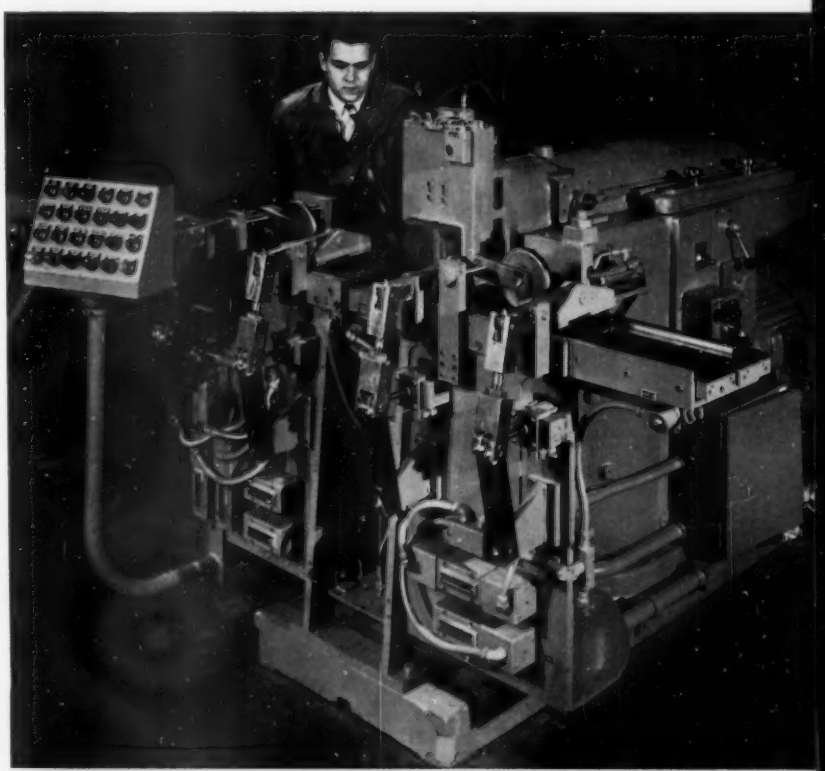
AUTOMATIC COPY LATHE is designed for venturi shapes, nozzles and other long, slender workpieces with relatively large diameter changes. It is used in missile work.





COPYING ATTACHMENT for constant cutting speed lathe. A 26-inch diameter hemisphere is being turned here. A cross-center facing arrangement automatically brakes and stops the spindle as the tool reaches the centerline, then reverses and restarts spindle rotation. At the same time, feed direction is reversed and the tool continues feeding to the back side of center, all under tracer control.

Shaper Has Automated Cycle



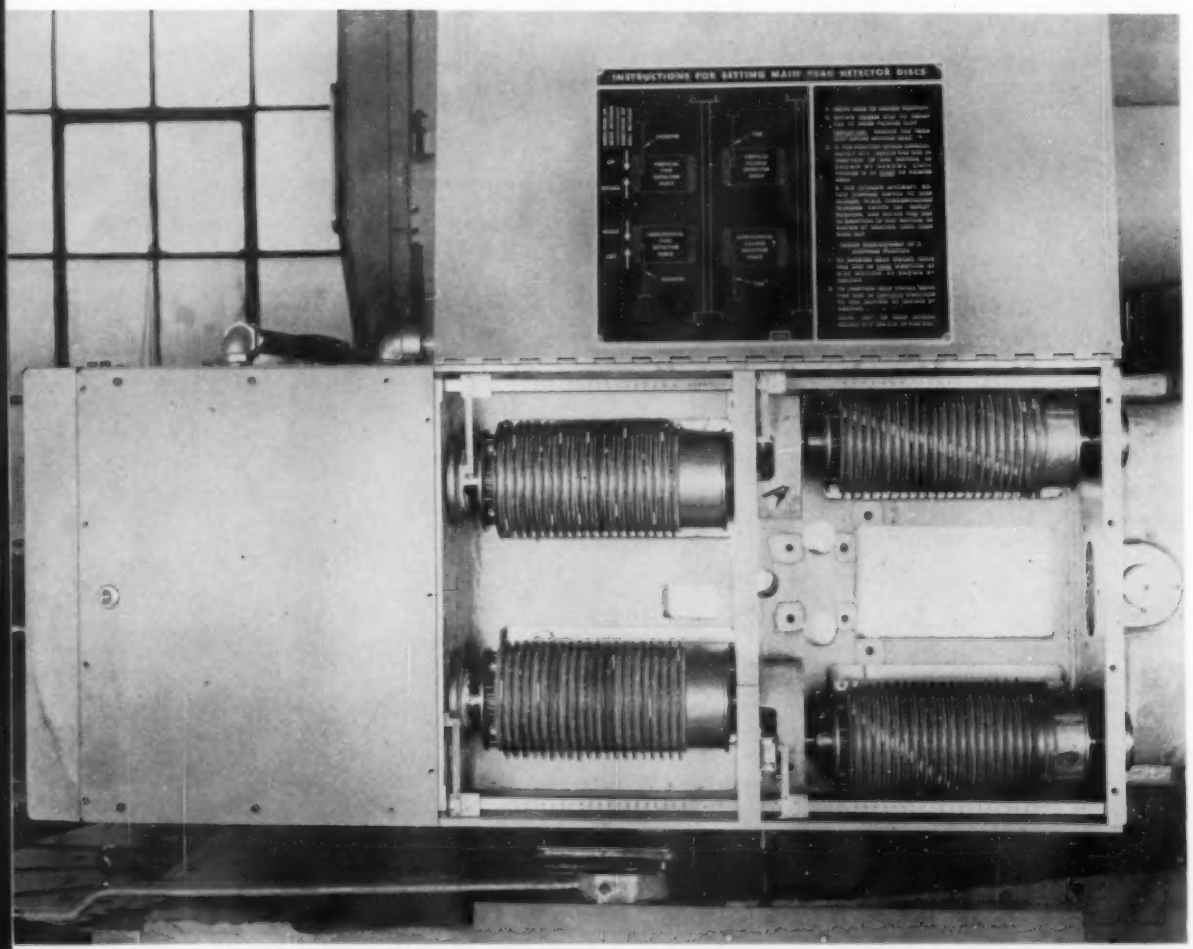
With full automatic cycle, including loading and unloading, this Rockford Machine Tool Co. shaper can be installed in continuous production lines. The machine finishes one vertical and one angular surface on the edge of each of two steel plates simultaneously, prior to bending the plate into a circle and butt-welding to form the shell for a sleeve bearing. Machining is completed in nine cutting strokes, utilizing a cutting speed of 40 fpm and a return speed of 100 fpm. No attention is required from the operator except to change tools. Covers have been removed from the machine shown here.

"Silent Sentinel" Sizes Work On Vertical Turret Lathe

Precise control over both horizontal and vertical motions of vertical turret lathe heads is made possible by an automatic sizing device that relieves the operator from the need to manually gage the part during machining. Over-all productivity of the machine is much increased.

The device, standard on Bullard V.T.L.'s, automatically brings the cutting heads to a stop when they reach preset positions during each stage of machining. Repetitive accuracy is 0.0003 inch in either axis.

The system makes use of rotating drums (illustrated) that are made up of adjustable disks—one for each positioning function. These disks provide the means for making contact with a series of corresponding switches that operate a solenoid valve. The valve controls the engagement of the clutches that apply power to the horizontal feedscrews. Disk settings are made by the operator during setup.



Stick-Slip

what it is—
what to do about it

By Harry Conn*
Chief Engineer
Scully-Jones and Co.
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The detrimental effects of stick-slip persistently plague mechanical designers. The author presents an analysis of how and where stick-slip occurs and gives design approaches to take to minimize or eliminate it in machine tools.

WHEN STICK-SLIP occurs between machine tool components it can have adverse effects on tool life and workpiece finish, complicate problems of positioning and cause excessive machinery wear. It is one of the major problems in sliding one surface over another.

When one body slides over another under a steady pulling force, the movement sometimes proceeds at a constant or nearly constant velocity; at other times the velocity may fluctuate widely. This stick-slip action results from the fact that the frictional force does not maintain a constant relationship to some other variable. The variable may be distance, time, velocity or normal force. Under certain conditions a critical value of any of these may produce a form of oscillation.

What Causes Stick-Slip: When attempting to analyze or understand stick-slip, it is first necessary to review modern concepts of friction. Many ideas about friction accepted as fact 50 years ago are now known to be erroneous. As an example, it was formerly thought that friction was not affected by adhesion. It is now known that friction does arise from the adhesion of molecules on surfaces in contact with other. The bond between the surfaces becomes so strong at some points (asperites) that tiny fragments are torn off one surface and stick to the other. Fluid friction, of course, stems from molecular cohesion.

Another concept formerly held regarding friction is that frictional force is independent of the sliding velocity. It has been known for some time that this is not true. In fact, the coefficient of friction between two bodies may vary as much as 30 to 50 percent according to the speed of motion.

Frictional force resisting the start of sliding of two bodies at rest is greater than the resistance after they are in motion for most common materials. Therefore, two coefficients of friction exist; one for static conditions and another—a kinetic coefficient—for surfaces in motion. Both the kinetic and static coefficients vary. The kinetic coefficient

*Senior member ASTME Chicago chapter.

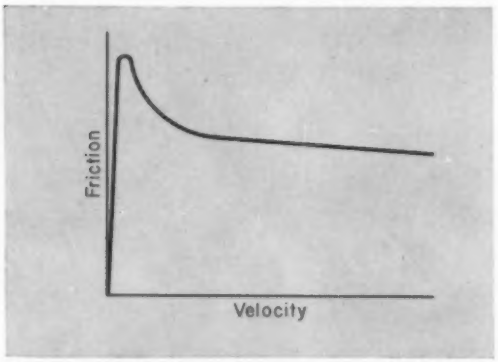


Fig. 1. Typical friction-velocity curve of a sliding body. After reaching a maximum, friction begins to steadily diminish as shown by the negative slope.

drops off as the sliding speed reaches a certain velocity. In other words, at low velocities, the friction increases with the velocity until a certain point is attained, then the friction begins to steadily diminish. This characteristic is illustrated by the plot of a friction—velocity curve shown in *Fig.* 1. It has also been found that for some combinations of materials that kinetic friction also begins to increase after a certain velocity is reached. Static friction is dependent to some extent on the time surfaces have been in contact with each other.

Nature of Stick-Slip: The only completely satisfactory way to represent the friction coefficient for any pair of surfaces is by two plots, one of the static coefficient as a function of time of contact, the other of the kinetic coefficient as a function of sliding velocity. It is the breakdown of the third "law" of friction—the variation of frictional force with velocity—that causes stick-slip. The phenomenon can be demonstrated with the apparatus shown in *Fig.* 2.

Suppose a block is attached to an anchored spring and placed on a slab which is set in motion at a slow speed, *Fig.* 2. At first the block is dragged

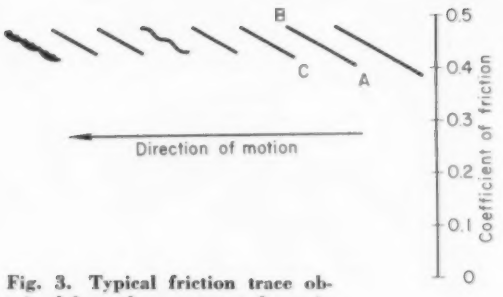


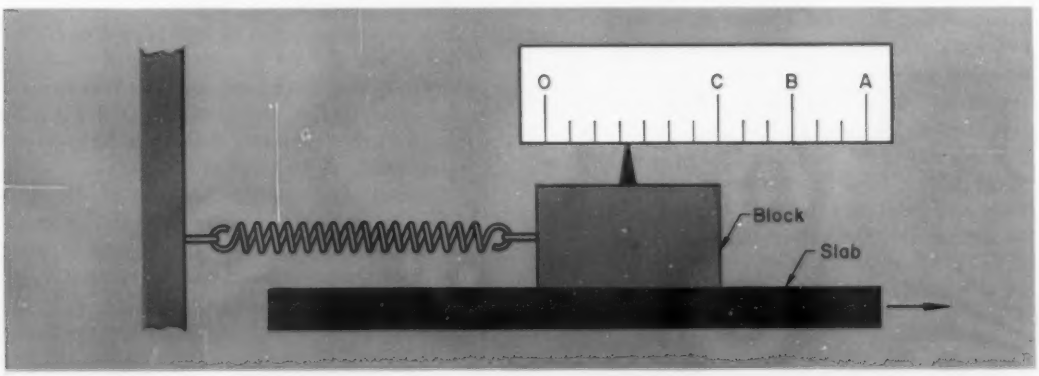
Fig. 3. Typical friction trace obtained from the apparatus shown in *Fig.* 2. Discontinuities represent reversal of motion of the blocks.

along on the moving slab—it will not be held back by the spring. It slides on the slab until the spring pull is equal to the static friction. The pull of the stretched spring reaches that value when the block arrives at point A of *Fig.* 2. Now the block begins to slip on the moving surface. As soon as it does, the lower kinetic coefficient of friction is in effect, and the block slides rapidly toward the left. When it has moved back to point C, it comes to rest. Here the higher static coefficient takes charge, and the block again sticks to the surface and is dragged to A. It then slips back to C again.

The same experiment has been performed by pulling a steel block with a spring fastened to a lathe carriage and a pointer also fastened on the carriage aimed at the middle of the steel block.

At the point B on the scale, half way between points A and C, the pull on the spring is equal to the kinetic friction. If the static coefficient were the same as the kinetic, the block would be dragged to this point and then stay there, sliding on the moving slab beneath it. However, the block oscillates about this position, sticking and slipping. The condition is complicated by the fact that, during motion, the friction coefficient varies with changes in sliding velocity. Whether stick-slip may occur can be determined in any given situation

Fig. 2. Apparatus used to demonstrate the stick-slip phenomenon.



simply by observing the direction in which this relation is changing as is evident in a plot of friction and velocity such as shown in *Fig.* 1.

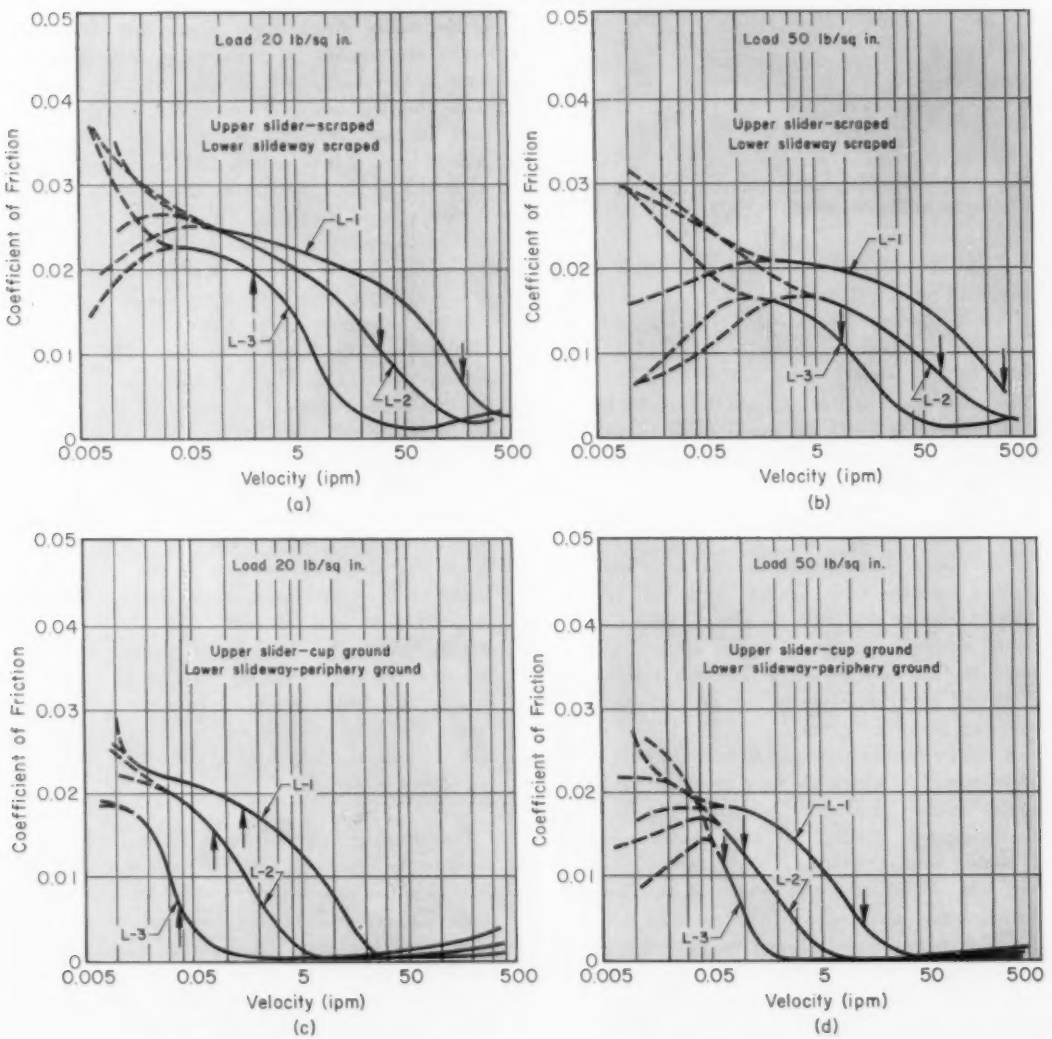
Application to Machinery: Very few mechanisms in use contain sliding surfaces attached to springs. However, when solid bodies are pressed together there is some elastic displacement or deformation of the material resulting in an effect like the operation of the spring in *Fig.* 2. Oil is actually so compressible—and long hydraulic cylinders so rubbery—that they have too low a spring rate for use on servo controlled machines.

A typical friction-trace that can be obtained from the mechanism in *Fig.* 2 during operation is shown in *Fig.* 3. During the interval that the block sticks to the slab in *Fig.* 2 they travel together. At B in Fig. 3, the block breaks free and slips rapidly to the position corresponding to point C. The data shown in *Fig.* 3 represent the dotted lines portions of the velocity friction curves shown in *Fig.* 4. Each solid line in Fig. 4 is preceded by two dotted lines that converge into the solid line. The dotted lines are the areas or velocities where stick-slip occurred and show the friction coefficient fluctuations which cause it.

Machine tool ways are usually designed to work satisfactorily within definite normal force limitations. The loading on slideways is usually expressed in terms of the total load divided by the bearing area, and common values range from 10 to 80 psi.

The graphs in *Fig.* 4 show the effect upon stick-

Fig. 4. Variation of friction with sliding velocity under various conditions. Each solid line represents a specific lubricant.



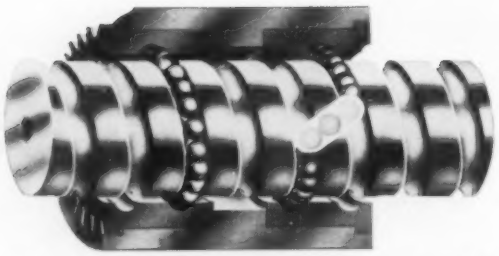


Fig. 5. Recirculating ball screws increase stiffness of a drive assembly and improves damping.

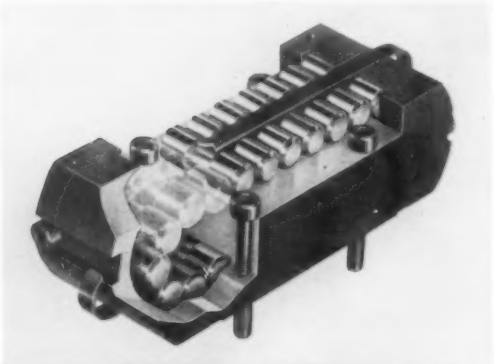


Fig. 6. Recirculating roller bearings convert sliding friction to rolling friction.

slip and kinetic friction that velocity, finish of surface, unit loading, lubrication have and the velocity at which stick-slip disappears. The stick-slip disappeared in these experiments at velocities indicated by the converging of dotted lines into solid lines. The small arrows indicate the kinetic friction and velocity at which all traces of vibrations disappeared. The dotted lines which converge show how the friction fluctuates. The lines labled L-1, L-2 and L-3 in each of the charts correspond to different lubricants.

The upper slider would be the lathe carriage, milling machine table, planer table, etc. and the lower slideway the lathe or planer bed. Conventional scraped surfaces show the highest friction forces and the most stick-slip. The best combination is for the upper slider to be cup ground and lower slideway periphery ground.

It can be readily seen that stick-slip occurs at the lower velocities which are most troublesome in numerical-control positioning when nearing the exact predetermined location. It also causes vibration or chatter configurations on workpiece and shortens tool life. When stick-slip occurs it can increase the vibratory amplitudes of the machine and also the relative amplitude between the cutting tool and the workpiece, which in turn builds up the magnitude of the cutting force. The machine thus contributes to the progressive increase in chatter.

Lubrication: The lubricants used for the test were straight mineral oils having viscosities of the following approximate values at 70 F.

L-1: 100 Redwood 1 secs
L-2: 500 Redwood 1 secs
L-3: 1500 Redwood 1 secs

The main effect due to lubricant viscosity was that stick-slip exisited up to a considerably higher velocity with the lowest viscosity lubricant than with the two heavier oils. The heavier oils show better damping characteristics.

It can be seen by examination of the curves in *Fig.* 4 that all curves appear to have a similar form consisting of a descending portion in the region of boundary and mixed lubrication followed by a slow ascent as full hydrodynamic lubrication supervenes. This would tend to confirm DeHart's concept that fluid-film friction can be higher, equal to, or less than dry sliding friction.

Reducing Stick-Slip: There are three main ways of reducing or eliminating stick-slip. The first is to change the sliding velocity; in most cases this will mean increasing the sliding velocity and, in rare instances, reducing the velocity. A second method is to reduce the stored energy (such as in the spring) the intermittent release of which is the cause of stick-slip. This may be done by using a more efficient mechanical leadscrew and nut; or, as this is now called, a ball bearing leadscrew. It is possible to have stick-slip in the ordinary screw and nut assembly due to about 45 percent of the torque being dissipated in friction. The leadscrew assembly shown in *Fig.* 5 enables the designer to use the second method of reducing the leap-frog tendency. In other words, increase the stiffness of the drive and also improve the damping in the system when possible. The recirculating ball bearing leadscrew is another example of reducing friction by changing from sliding to rolling friction. When the operating function is one of rotary-to-linear motion conversion, efficiencies will generally range from 90 to 98 percent.

The third method is to reduce friction by changing from sliding to rolling friction or to the expensive full hydrodynamic lubrication of the surfaces. The most modern way of using rolling friction is to use the recirculating roller type way bearing shown in *Fig.* 6.

Positioning Applications: There are five main areas in the design of machine tools equipped with numerical controls or tracers which the ball bearing leadscrew and recirculating way bearings can have advantageous effects. Those areas enable the designer to evaluate, apply and use the correct position regulators. The five interrelated areas are sensitivity or gain, velocity error, frequency response,

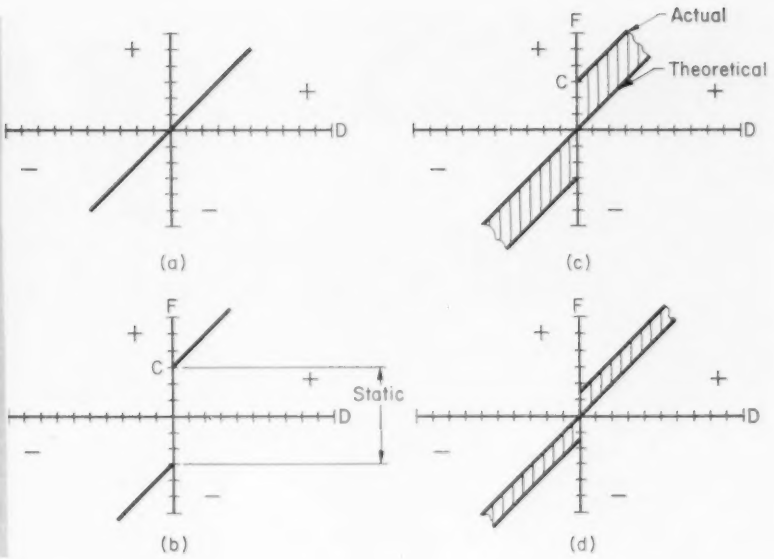


Fig. 7. Displacement force diagrams: (a) theoretical conditions with no friction; (b) actual conditions with friction; (c) range between actual and desired conditions; (d) improved system with narrow range or difference.

feedback and instability or hunting.

Modern positioning equipment will move a heavy machine tool table in rapid traverse at velocities of 200 ipm to within 0.100 inch of the prescribed position. Then at a slow velocity, the precise position can be located within 0.0005 inch with a repeatability of 0.0001 inch with the final movements in increments as low as 0.0001 inch. The ratio of rapid traverse velocity to the creeping speed at the precise location is 30,000 to 1.

It is in the final approach speed to the precise location where stick-slip is troublesome and sometimes disastrous. The friction at the slow speed changes from the kinetic values to static values as represented by the dotted lines of *Fig.* 4.

To be able to incorporate these low-friction standard components into any machines, an important point to consider is the critical speed. The critical speed and the natural frequency are practically the same, and this speed should be avoided. Recommended design practice for ball bearing screws is to keep operating speeds at least 20 percent above or below the critical value.

Servo Mechanisms: The main problem in designing an accurate servo system is the large and variable friction encountered which causes continual changes in the servo properties of the machine. It is not necessary that the designer strive to eliminate friction. His goal should instead be to bring it within limits where it contributes to the stability of the system without inhibiting the action or reducing the accuracy of the positioning.

It is desirable to have a servo system so arranged that the velocity of the resultant motion is nearly proportional to the magnitude of the signal. This requires that the velocity resulting from a given signal strength be consistent. The amount of force required to start motion should not be unduly large, lest immediately after breakaway a sudden and unwanted acceleration should result and cause an overshoot and then a lengthy excursion or oscilation.

The force-displacement diagrams shown in *Fig.* 7 portray the problem of final precise positioning and the effect of stick-slip. In *Fig. 7a*, the slanting line shows how the motion would be if there was no friction in the system. In other words displacement would always be proportional to the force but the system would be unstable until clamped. Because of friction, stick-slip and phase displacement, a more real resultant is shown by the discontinuous slanting line in *Fig. 7b*. In this case a certain amount of force is put into the servo system before displacement results. The increasing force finally causes movement at C in *Fig. 7b*, and then displacement becomes proportional to force. Reducing of friction and eliminating of stick-slip reduces the width of the band shown in *Fig. 7c*, which shows both desired and actual force-displacement characteristics. A typical improvement is shown in *Fig. 7d*. This system still retains some stability at the final positioning point.

Standardization of contour machining and point-to-point positioning tolerances can be materially assisted by progress in design aimed at elimination or reduction of stick-slip. Emphasis on improvement efforts must, however, be directed with care to obtain the most economical results. The task of determining the most vulnerable points of attack can be considerably eased by an understanding of causes and effects of stick-slip.

DETERMINING THREAD by differential gaging

By Russell V. Johnson

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With a simple setup, the accuracy of screw threads can be quickly checked. The methods described by the author are used to make sure that threads conform to the rigid specifications established by the Federal government for Space-Age applications.

RECOGNITION OF THE NEED for better holding capabilities of screw threads in the automotive, aircraft and missile industries has resulted in specifications calling for more rigid control of the various screw thread elements—lead, angle, straightness and roundness. Typical specifications appear in *Screw Thread Standards for Federal Services, 1957, Handbook H-28—Part I.* This article shows how to make sure that screw threads conform to these specifications. Indicating thread comparators are used.

Before discussing inspection methods, a review of the *Screw Thread Standards,* paragraph 8, page 22, may be helpful:

> Limits of size.—With respect to the pitch diameter limits of size, it is intended, except as hereinafter qualified, that no portion of the complete thread be permitted to project beyond the envelope defined by the maximum-metal limits on the one hand, or beyond that defined by the minimum-metal limits on the other, and thus be outside of the tolerance zone. . . . Also, the diameter equivalent of the variation in any given element, except pitch diameter, shall not exceed one-half of the pitch diameter tolerance. Deviations from specified size and profile include variations in lead, uniformity of helix, flank angle, taper, out-of-roundness, and surface defects. Accordingly, values are given in Table III, 11, for the standard thread series and classes, of one-half the pitch diameter tolerances and the deviations in lead and flank angle which are equivalent thereto. Flank angle equivalents are based on a depth of thread engagement of 5 H/8.
>
> The diameter equivalents of variations in lead, uniformity of helix, and flank angle are always in the direction toward maximum material, that is, they increase the virtual diameter of the external thread and decrease that of the internal thread. Thus, the maximum material pitch diameter limits are a limitation of the virtual diameter (effective size) and are so specified herein for all thread classes. Variations in taper and roundness of the pitch diameter, together with variations of the pitch diameter as a whole, may be in the direction of minimum material, and thus the minimum material pitch diameter limit may be specified as a limitation of the pitch diameter as a single element.

When indicating thread comparators are used to inspect the product thread the following interpretations and procedures apply:

1. In order to be acceptable, the product thread, when measured on a thread comparator having Go or maximum-metal size gaging elements, should at no point give a size indication which is greater than the Go setting.
2. In order to be acceptable, the product thread, when measured on a thread comparator having Not-Go or pitch-diameter gaging elements, should at no point give a size indication which is less than the Not-Go setting.

The limits of size include straightness and roundness. It is usually permissible, however, for the starting threads to be slightly undersized.

In addition to these two rules, *Screw Thread Standards* states: "Also, the diameter equivalent of the variation in any given element except pitch diameter shall not exceed one-half of the pitch diameter tolerance." This is interpreted to mean that even though the product thread falls within the limits of size of maximum and minimum metal,

QUALITY

there must be no deviation in lead or angle that exceeds a diameter equivalent to one-half the pitch diameter tolerance.

Further, since any deviation in lead or angle always increases the size of the product thread in the direction of maximum metal (except in the case of a perfect thread), the maximum-metal or Go size indication will always be greater than the minimum-metal size indication. This difference in size indication is referred to as a "differential reading." For differential readings, a third rule is:

> 3. When the differential reading—the difference between the indicated maximum-metal size and the indicated pitch-diameter size—is greater than one-half the pitch diameter tolerance, the product thread must be further analyzed to assure that there is not excessive deviation in any one element of either lead or angle.

Deviation in Lead: In the examples that follow, the Go and Not-Go gaging elements may be either segments or rolls. Type BG segments and Type CN rolls are used in the illustrations.

In *Fig.* 1, which shows a perfect thread, the differential reading is zero. In other words, the minimum-metal size, or pitch diameter, is equal to the maximum-metal size indication. Conversely, in *Fig.* 2, which illustrates a thread with long lead, there is a differential reading. In both illustrations, an arbitrary pitch diameter tolerance of 0.004 inch has been selected.

Fig. 2 shows a differential reading of approxi-

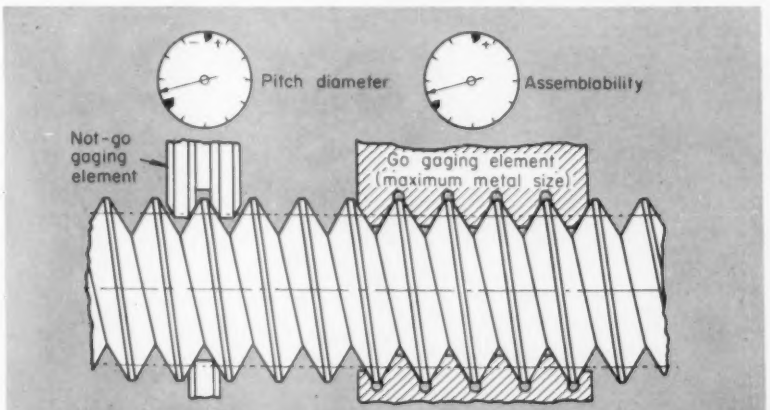


Fig. 1. In the case of a perfect thread, the differential reading (from the Go gage and Not-Go gage) is zero.

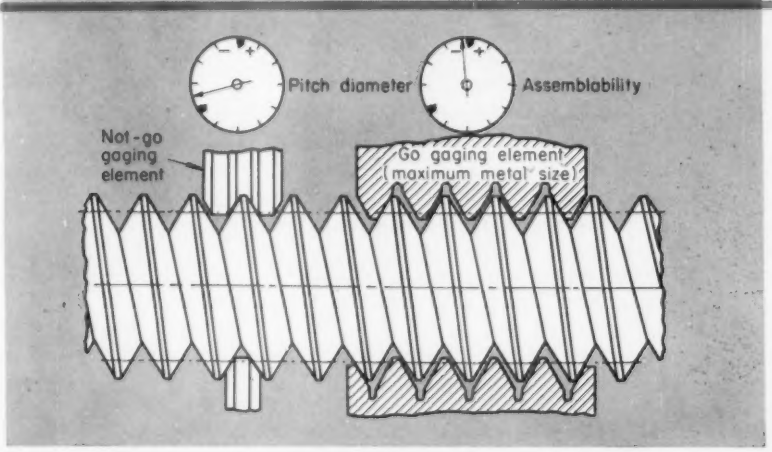


Fig. 2. In the case of a thread with long lead, a differential reading is obtained directly.

mately 0.003 inch, which is in excess of one-half the pitch diameter tolerance. By itself, this cannot and does not determine the acceptability of the thread; however, it does indicate that the thread must be further analyzed to determine that no single element in the thread causes a pitch diameter equivalent variation that is greater than one-half the pitch diameter tolerance, which, in this case, is 0.002 inch.

Deviation in lead is, perhaps, the most important deviation found in threads, since lead affects pitch diameter in the ration of 1.7 to 1 on a 60-deg thread. To quickly determine whether or not the amount of deviation is excessive, the following method is recommended.

First, determine the straightness of the thread by checking for taper on the Not-Go gaging element. Second, engage the thread over the entire length of the Go gaging element. Finally, engage the first full thread of the part being checked in the Go gaging element and note the size indication.

If the indicated size difference between full-length engagement and first full thread engagement in the Go gaging elements (exclusive of taper) is greater than one-half the pitch diameter tolerance, it is evident that the lead deviation is excessive.

In the second and final steps, the results are not affected by deviation in product thread angle, since the amount of flank angle contact in both steps is equal. The only difference in contact in these two steps is the length of engagement.

Determining Deviations: Various deviations in threads can be readily detected by using differential readings obtained from any of the indicating thread comparator combinations shown in the following illustrations. This enables corrective action to be taken immediately and provides inspection and manufacturing departments with a specific analysis of quality. The most common deviations in product threads, such as off-lead angle error, taper, out-of-roundness, excessive root fillet and so on, can be quickly detected.

The full length Go gaging elements contact only the largest diameter of the product thread. The

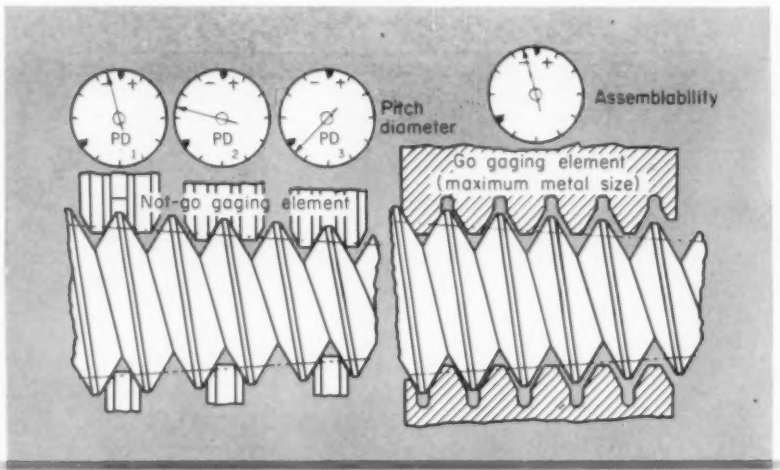


Fig. 3. Taper and straightness are measured by moving the Not-Go gaging elements to different positions along the thread.

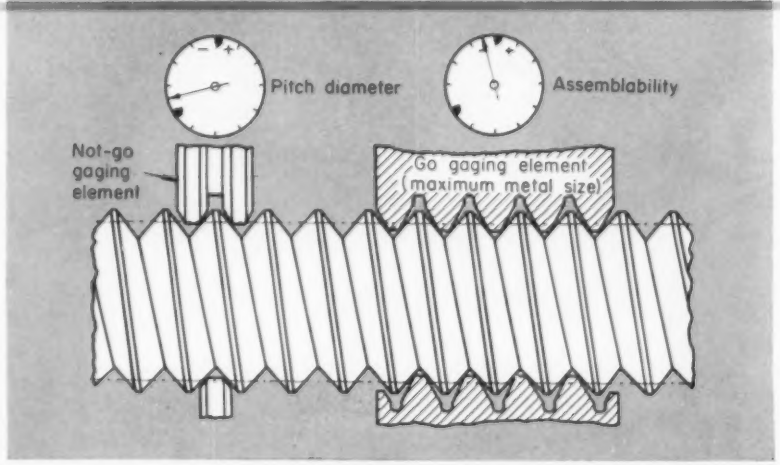


Fig. 4. Go gaging elements are affected more by deviations in thread angle than the Not-Go elements. A differential reading is obtained.

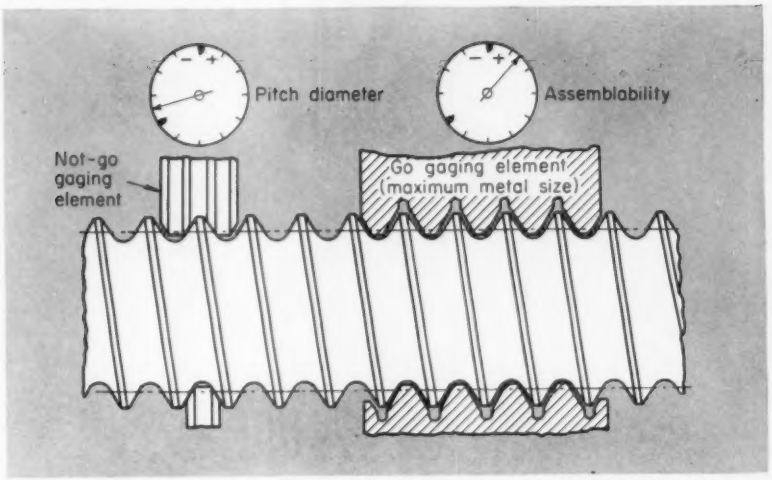


Fig. 5. In the case of excessive root fillet, the Go gaging element indicates oversize. Not-Go elements continue to measure actual pitch diameter. A differential reading results.

Not-Go gaging elements contact only one thread at a time on the product and give the pitch diameter of the thread at the actual point of measurement. As shown in *Fig.* 3, the Not-Go gaging element is used to check the thread at several points, depending in the thread length, to determine straightness—or taper—of the thread.

Angle Deviation: The Go gaging elements, with lesser truncation and narrower relief, contact more of the thread flank angle than the Not-Go elements. Thus the Go elements are affected to a greater extent by deviations in thread angle than the Not-Go elements, causing a differential reading, *Fig.* 4.

The amount of thread angle deviation, expressed in diameter equivalent variation, is determined by comparing the size indications given on both the Go and Not-Go elements. In both cases, only the first full thread should be engaged in the elements. This procedure is supplemental to the more accurate determination of thread angle by optical projection.

Minor Diameter: Oversized minor diameter and excessive root fillet are usually caused by worn threading tools. Full-form (Go) comparator elements contact the minor diameter of the product thread and are forced out of thread, resulting in an oversized maximum-metal indication. Not-Go elements, with greater truncation, are not affected by this condition and continue to measure actual pitch diameter. A differential reading results, as can be seen from *Fig.* 5.

When this occurs, the possibility that the differential reading is caused by off-lead should be checked. Then the product thread is engaged on the first full thread of the Go gaging elements. If the indicator reading is greater than the maximum-metal size setting, and if pitch diameter size is within limits, the interference is caused by an excessive root fillet condition.

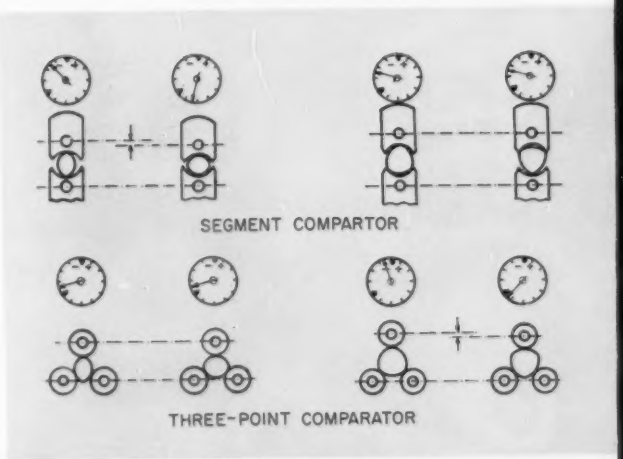
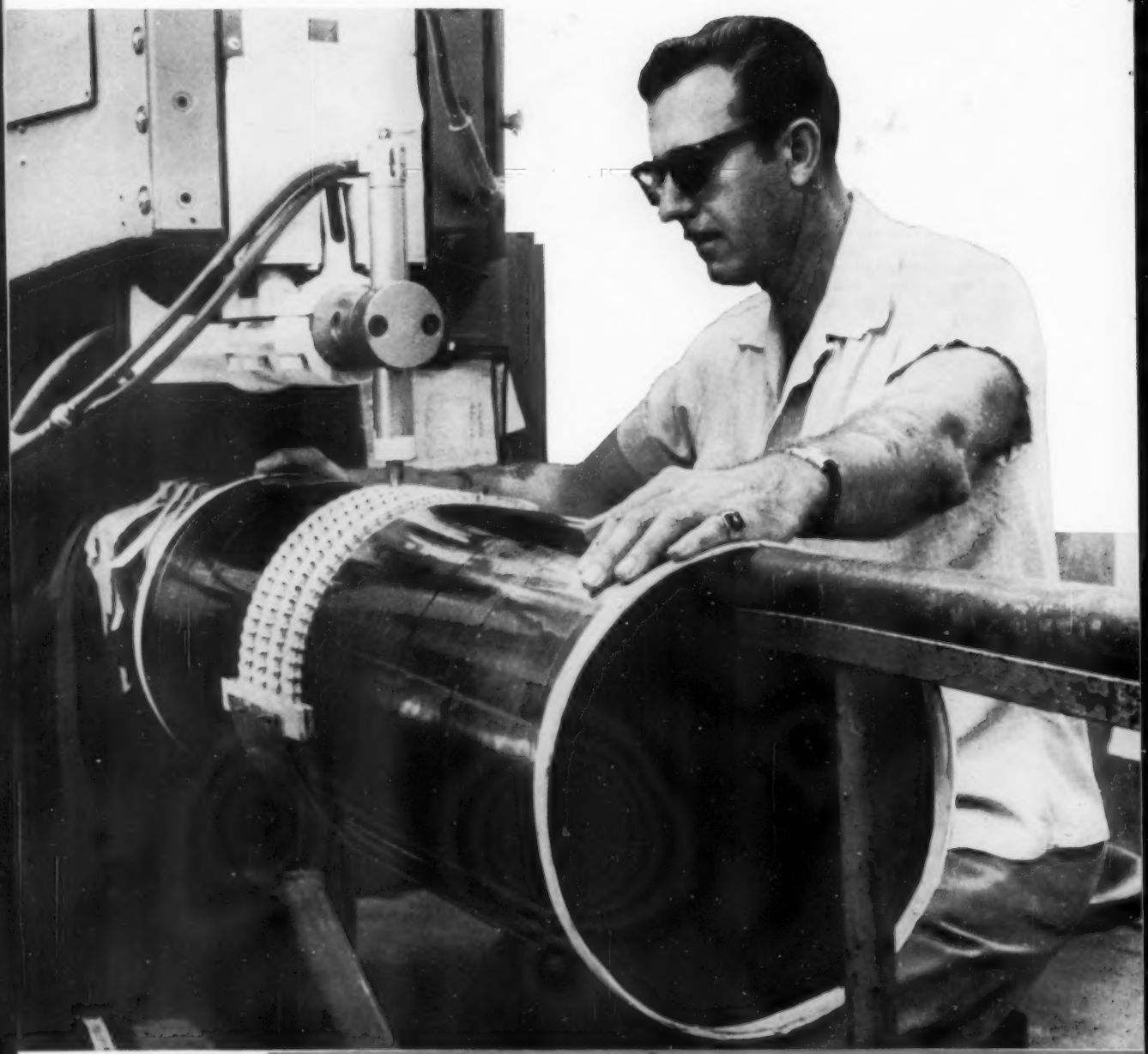


Fig. 6. Segment comparators detect ovality but not clover-leaf conditions. Three-point comparators detect clover-leaf conditions but not ovality.

Roundness: Out-of-roundness in a screw thread may be ovality or one of several clover-leaf conditions, *Fig.* 6. Ovality can be checked by a segment comparator. This type of comparator can engage—by two-point contact—a screw of smaller diameter than the segments. Segment comparators cannot detect clover-leaf conditions. A three-point contact accurately measures clover-leaf conditions but does not necessarily completely detect ovality.

While the setups illustrated are simple, they make it possible for any plant to make sure that screw threads meet the specifications established in *Screw Thread Standards.* Mechanical indicators have an important role in the Space Age.

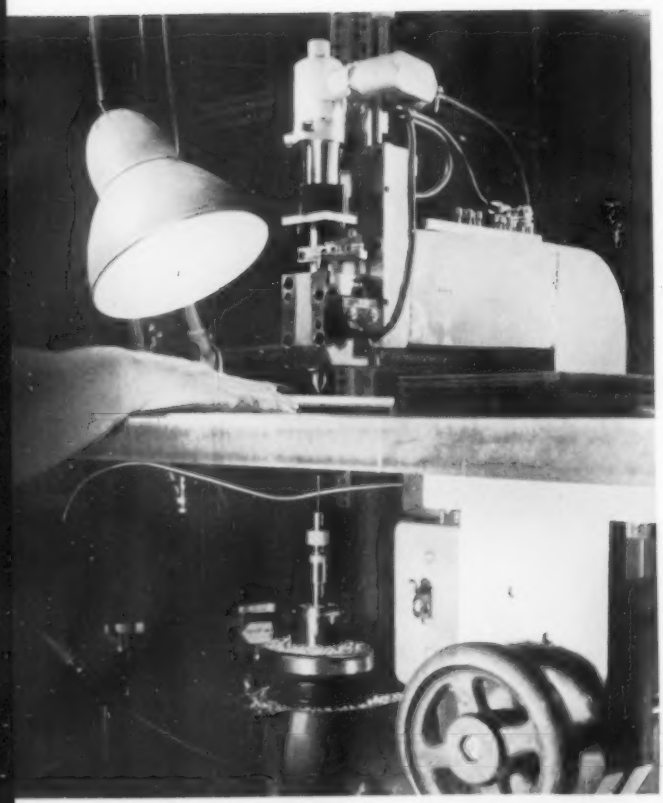


STAINLESS STEEL, welded in foil-gage strips to a rocket chamber, helps to restrain force surge in a rocket motor case. Multiple strips of Allegheny Ludlum ultrahigh-tensile AM-355, a precipitation hardened stainless steel, are wound then spot-welded to the chamber. Finished chambers can withstand hoop stress of 305,000 psi.

Opposite Page

SPHERICAL ROLLER BEARINGS are subjected to 758 individual gaging operations at Link Belt Co.'s new bearing plant in Indianapolis. Now in full production, the new plant has a 50 percent greater capacity than the plant which it replaces.

TOOLS at work



GANG DRILLING of five circuit boards is accomplished with a special drilling machine at Librascope Div. of General Precision Inc. Boards are placed in a positioning fixture which has the drilling pattern etched into the metal surface. The positioning finger is guided along the pattern by the operator. As the finger drops into each indentation in turn, the operator touches a toe switch and a carbide drill located below the table automatically drills the holes.

TOOLS at work

LARGE CASTING is tested for cracks with a CRV-20 Magnaflux-Magnaglo power pack unit using an overall magnetization technique. High currents are employed in one, two or three of the output circuits to replace localized prodding. Total inspection time for the 32,000-lb casting is approximately two manhours using expendable, water-suspended detection material. Complex shapes can be checked.

developing STRONGER METALS

Basic research on the mechanical properties of metals at the National Bureau of Standards has led to many practical results. An ultrahigh-strength steel has been developed and studies of metallurgical structures and temperature effects have shown how to minimize fatigue and cracking of metals in service.

Fig. 1. Microscope is used with fatigue-testing machine that applies torsional stress to small, flat specimens. Specimen is covered with transparent tape to trap gas produced by surface chemical reactions.

TODAY METALS ARE OF MORE IMPORTANCE to scientific and engineering progress than at any time in history. As man ventures into space, metals with improved mechanical properties are a necessity and new alloys are vitally needed. Much fundamental research is being devoted to this problem. At the National Bureau of Standards, for example, instabilities in alloys, changes within the space lattice at the atomic level, surface reactions, the creep process, metal fatigue and all of the factors controlling the response of metals to external forces are being investigated. Results of this important basic research program are summarized in this article.

Metallurgical Structure: Metal fatigue is the most common cause of mechanical failures in service. Hence, much consideration is given to engineering design to increase the useful life of metal parts. In order to achieve optimum design, however, engineers must be able to predict the behavior of stressed components with a high degree of accuracy, and this ability requires an understanding of the relation between the structure of metals and the fatigue process.

It is well known that fatigue cracks generally start on pre-existing slip bands within the grains of a metal. The study of the conditions under which cracks start in commercial metals is difficult, principally because these metals are composed of a large number of infinitely small grains. The Bureau has produced aluminum specimens with grains 2 to 3 mm in diameter so that the behavior of individually stressed grains can be observed more readily.

In one study with these specimens, individual grains were found to act independently of their neighbors. There was no evidence that grain boundaries or interaction with neighboring grains promote cracking. It appears that the principal factor to be considered in the fatigue-crack initiation of polycrystalline aluminum is the resolved shear stress on the plane of easy slip in the slip direction.

Results of another study show that the preponderance of fatigue cracks starting at the edges of a metal specimen is caused by the stress pattern, rather than by lower fatigue strength at the edges.

Chemical reactions at the metal surface are known to have an important influence on fatigue behavior. It has recently been observed that if transparent tape is applied to the surface of a fatigue speciment, *Fig.* 1, bubbles form under the tape at about the same time that fatigue cracks are initiated. These bubbles, *Fig.* 2, caused by gas liberated as a result of surface reactions, are expected to provide a useful means for studying such reactions.

For several years, X-ray diffraction techniques have been used to determine stresses that occur within a metal's structure. With these techniques, the lattice strain can be ascertained by measuring changes in interatomic spacing. Because of its selectivity and directionality, X-ray diffraction has advantages over other means for evaluating stresses.

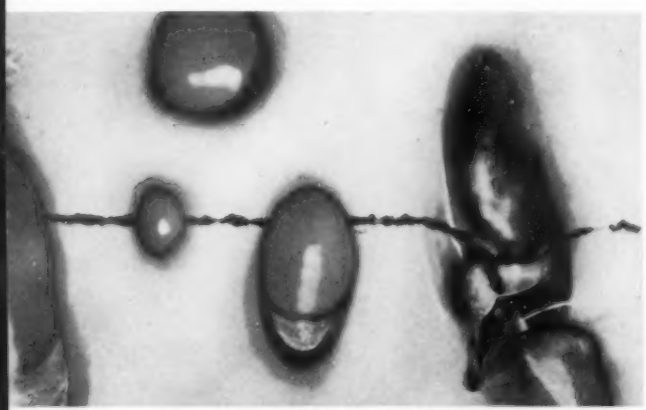


Fig. 2. Gas bubbles, produced by repeated stressing on the surface of an aluminum specimen, leave their imprint in the adhesive material of a piece of transparent tape applied to the metal. The horizontal line is powdered material extruded from a fatigue crack and some of the bubbles are associated with the crack.

Using the X-ray diffraction technique to study iron specimens, it was found that plastic deformation of this metal causes residual stresses to develop on a microscopic scale. An investigation of the elastic and plastic behavior of the ferrite lattice in a low-alloy steel showed that the stresses observed by X-ray diffraction exist in a relatively undistorted crystalline material. These stresses were balanced by oppositely directed stresses, either in distorted portions of the crystals adjacent to grain boundaries or in slip bands.

In two-phase alloys the thermal expansion coefficients of the two phases usually differ. Consequently there is a tendency toward unequal changes in the volume of each phase as the metal cools from the liquid state. The unequal volume changes cause intergranular forces known as textural stresses to arise. These stresses are to be distinguished from the other kind of internal stresses—body stresses—occuring in metals.

Textural stresses have been measured by X-ray diffraction. Results indicate that a completely stress-free condition cannot be obtained in metals that have more than one phase. Textural stresses must therefore be considered in investigations to determine the causes of corrosion, metal fatigue, and crack formation in metals used by industry.

Temperature Effects: Changes that metals undergo at high temperatures are becoming more and more important to the development of rocket machinery and astronautical devices. To a somewhat lesser degree, the effects of very low temperatures on the mechanisms of deformation and fracture of metals are of concern. As new test methods are devised, investigations of high-purity metals and the newer alloys are proceding under both types of environmental conditions.

Titanium and its alloys, because of their high strength-to-density ratios and high resistance to corrosion, are promising materials for many low-temperature applications and for certain aircraft and missile components. It is necessary to know how titanium and its alloys react at low temperatures under both uniaxial and multiaxial tensions in order to understand their behavior. Several investigations have been conducted at temperatures down to —196 C to evaluate the combined influence of prior strain-temperature history and notch geometry on the tensile behavior of commercially pure titanium and a titanium alloy containing aluminum and manganese. Notch geometry is significant because brittle failures at low temperatures are often associated with the presence of a notch, either as a design feature or as a defect.

Measurements of strength and ductility characteristics disclose that strength indices—that is, the resistance to flow, notch strength, true stress at maximum load and fracture stress—are generally increased, and tensile ductility is decreased, by increasing the notch depth or by lowering the test temperature. Analysis of the data indicates that these metals are very notch sensitive, particularly, as might be expected, at low temperatures.

The decrease in ductility with increase in depth and sharpness of notch is attributed not only to the initial stress concentration and accompanying severe strain hardening of the metal at the root of the notch, but also to the triaxial stress system induced by the notch. In general, the embrittling effect associated with the stress concentration is somewhat greater than that caused by the triaxiallity of the stress system. The results emphasize the importance of taking special care to eliminate notches. If they are unavoidable, their embrittling effect should be minimized by designing notches with the largest possible root radius.

It is fairly well accepted that the rate-determining factor during creep of metals is the motion of defects through the crystal lattice by thermal activation under high stress. Tests made at temperatures up to 1200 F have been conducted to determine and explain the structural changes that occur during creep, *Fig.* 3. It has been found that resistance to creep is materially increased by alloying the component metals and also by cold drawing, provided that the creep temperature is below the recrystallization temperature range. The increase in creep resistance caused by cold drawing is accompanied by a corresponding decrease in ductility, which is also affected by temperature and strain rate.

Fig. 3. Stress-rupture equipment used to obtain fundamental data on the creep behavior of metals at high temperatures.

High-Strength Steels: Fatigue strength of most ferrous metals is roughly proportional to their tensile strength. When steels are heat-treated to high hardness, this proportionality disappears and with increases in tensile strength to above 200,000 psi there is little improvement in fatigue strength.

Bureau studies show that retained austenite lowers fatigue strength. Under stress, retained austenite is transformed to untempered martensite, which probably accounts for the deleterious effect. With suitable heat treatment, however, retained austenite can be eliminated in most carbon and low-alloy steels. The results of this research are expected to have practical applications in the choice of industrial steels.

The Bureau's thermal metallurgy laboratory has recently been engaged in developing an ultrahigh-strength steel. By modifying Type 4340 steel an alloy was found that had high hardenability, sufficient ductility for use as structural members in aircraft and a tensile strength up to 300,000 psi. Although these properties were obtained in laboratory induction furnace heats, melted without slag, they may be duplicated or even improved upon in commercial steelmaking practice.

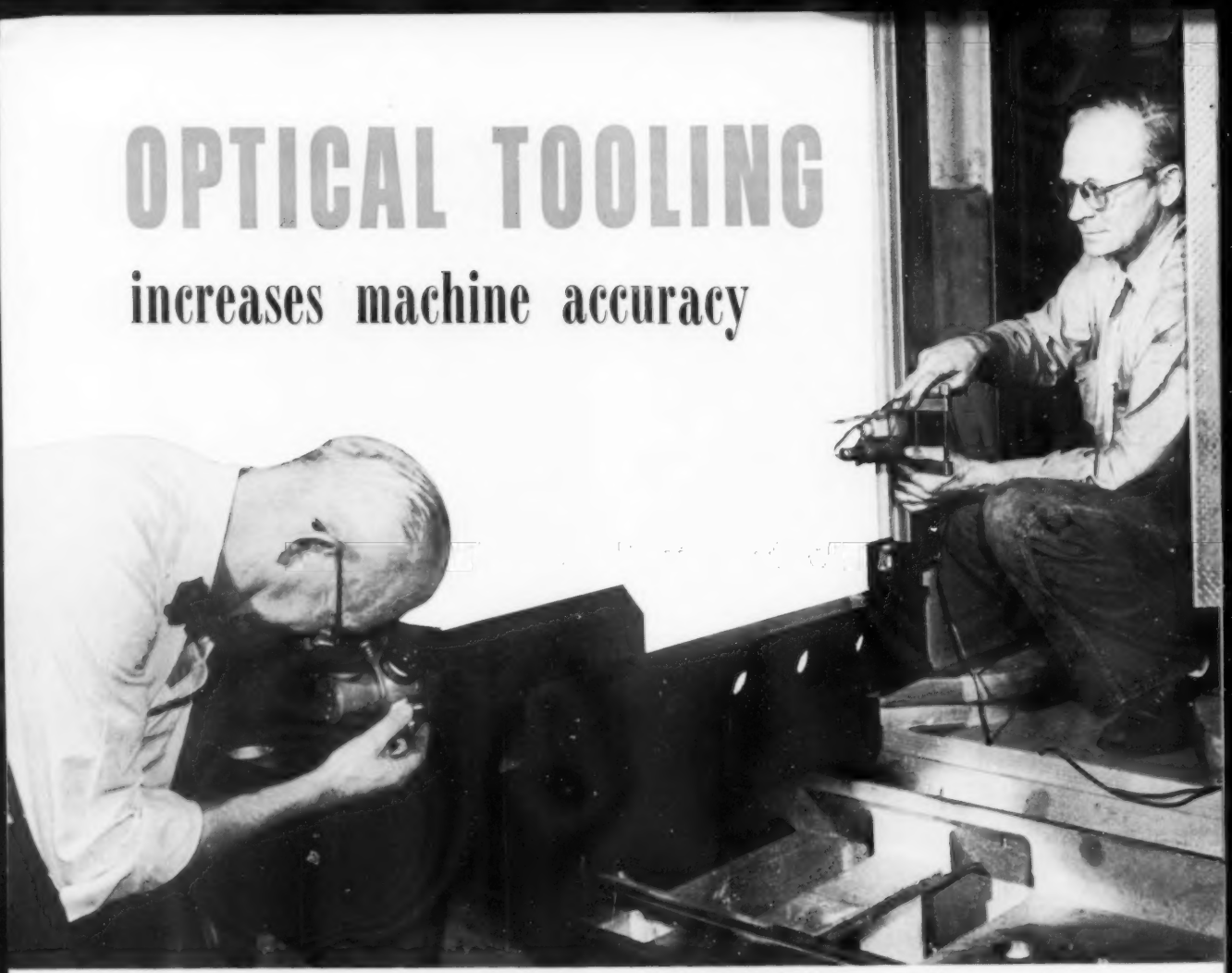
Gage Block Stability: At present, master gage blocks can be calibrated to an accuracy of one part in one million—to the nearest millionth of an inch for inch-long blocks. A goal has been set to increase this accuracy by a factor of 10. As part of this program, extremely stable materials are being sought for gage block construction—materials whose measured lengths will not appreciably change with time.

From recent experiments, nitrided 410 stainless steel appears to be a promising material for ultra-precise gage blocks. Specimens are corrosion-resistant under atmospheric conditions. Moreover, the gaging surfaces are extremely hard and can be finished to a high degree of smoothness, flatness and parallelism. Measurements thus far indicate that these specimens have the required dimensional stability. However, evaluations will continue for an extended period since previous observations have shown that the results of measurements over a year or two are not necessarily indicative of future behavior.

Looking ahead to the metallurgical requirements of a Space Age, the Bureau expects to place increasing emphasis on the study of all aspects of atomic structure that influence the behavior of metals in service. At present, techniques are being developed to obtain basic data that may point the way to new uses for metals. Ultimately this work may lead to new alloys that will withstand the most rigorous of environmental and physical conditions.

OPTICAL TOOLING

increases machine accuracy



Setup for checking perpendicularity of machine gib. Engineer's scale, clamped to gib and illuminated, acts as target.

NO MACHINE CAN PRODUCE accurate work unless the machine itself is made to high standards of accuracy. This is particularly true of large surface grinders and similar precision machines which are designed for the removal of relatively large amounts of material to close tolerances. Such grinders usually have one flat way and one V-way. These ways, which support the machine table, must of course be almost perfectly flat, and level with respect to each other. The gibs in which the wheelhead assembly travels must also be straight and they must be perpendicular to the machine ways.

Straightness of ways can be quickly checked with an alignment telescope. At Mattison Machine Works, the alignment telescope used for this purpose is mounted in a special holding fixture that is flat on one side (the flat is absolutely parallel to the line of sight) and V-formed on the other side. This allows it to be used interchangeably for checking both the flat way and the V-way.

The same alignment telescope, mounted in the same holding fixture, is used in checking the perpendicularity of the gibs on the machine column. The telescope is placed on a parallel laid across the ways for making these checks. Built-in optical micrometers allow vertical or horizontal displacement of a target or of the instrument itself to be read in thousandths of an inch.

A cube type optical square is also employed. This cube holds a large-aperture pentagonal prism. The optical cube is placed at the end of the parallel as illustrated above. An engineer's scale is clamped in position along the side of the machine gib. The scale is moved upward and reclamped for successive readings. Differences between readings indicate the perpendicularity of the gib. With this setup, deviations from perpendicularity as small as 0.00006 inch per foot can be measured.

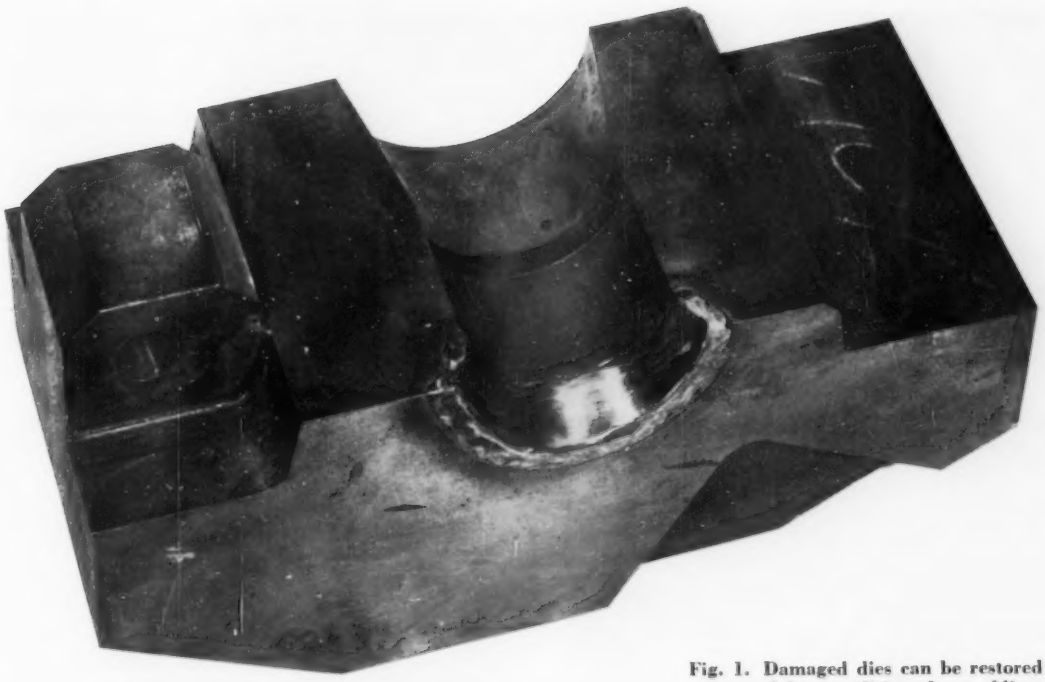


Fig. 1. Damaged dies can be restored to usable condition by welding.

welding renews damaged dies

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By utilizing the weldability characteristic of graphitic tool steel, damaged dies can be repaired and re-used. Repair, instead of replacement, means that both time and savings are gained. Techniques for obtaining crack-free hard-surface repairs are described in detail.

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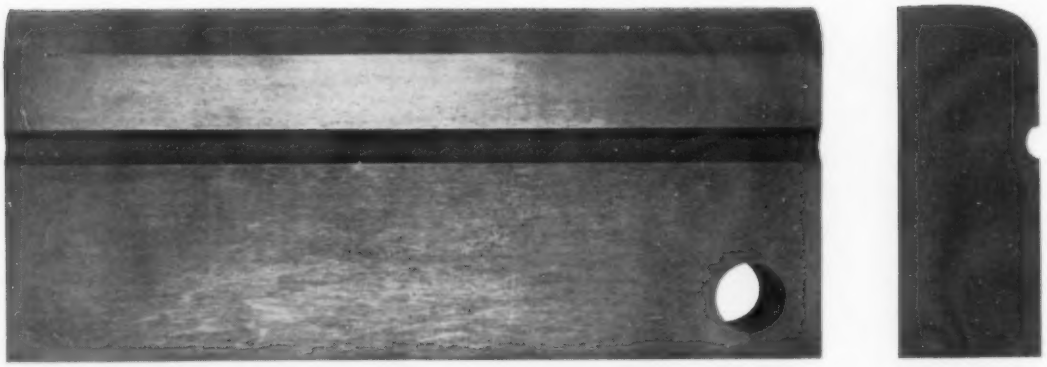
WELDABLE TOOL STEELS of high carbon content containing precipitated graphite and carbides throughout the microstructure are especially practical materials for dies. The graphite pockets act as stress relieving media by allowing local yielding when high thermal and transformation stresses are generated. Thus the steels are less prone to quench cracking in heat treatment and are more easily welded than the conventional steels. Weldability, in both the annealed and hardened state, makes die-repair work such as shown in *Fig.* 1 feasible. Success of the die repair is dependent on the selection of materials and the welding procedure used.

Material Selection: In selecting graphitic steel for making reparable dies, considerations are its heat-treat condition during welding and its heat-treat condition during use after welding. This deter-



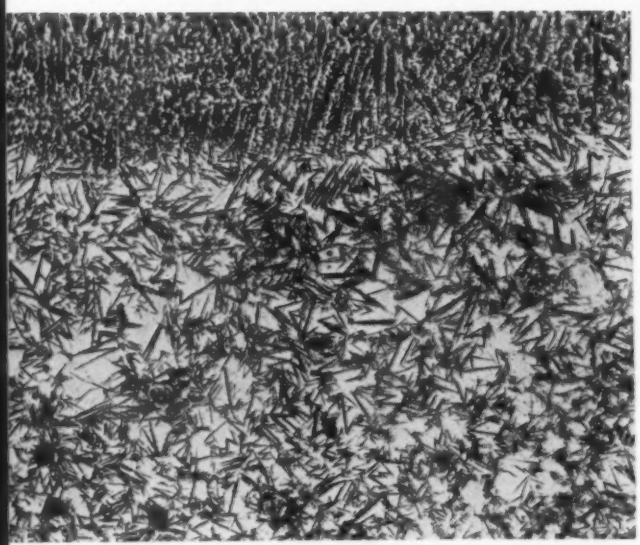


Fig. 2. (above) Typical die damage—a cracked surface, a spalled edge and a hole—that can be repaired when graphitic steels are used.

Fig. 3. (left) Weld microstructure on hardened and tempered graphitic tool steels, directely after welding. Weld metal at top.

mines the selection of welding electrode material and establishes the requirements for preheat and postheat treatment of both the weldment and the tool or die.

Water and brine hardening graphitic steel can be easily welded in the annealed state. But it is recommended that this grade be welded in the hardened and tempered state whenever possible, as the weld deposit requires a full anneal for satisfactory rehardening of the weldment. Simple tempering of the weld deposit does not assure against weld spalling during the severe water or brine quenches employed on graphitic steel. Welding in the hardened and tempered condition is recommended, as most tools needing repair are in the hardened-and-tempered state, and weld easily in this state.

Air and oil hardening graphitic steels can be welded in either the annealed or the hardened-and-tempered state, depending on which condition is more convenient. Weldments can be satisfactorily tempered for machining and rehardening without danger of weld spalling after rehardening.

Welding electrodes recommended for the production of weldments have one metallurgical characteristic in common with graphitic steels — a low hardening range that matches the recommended hardening temperatures of the graphitic tool steels, 1450 to 1500 F. These electrode materials are Eureka 71M, an oil-hardening tool steel material, T.G.A., an air-hardening tool steel electrode and 70W, an electrode with extra tungsten content.

Typical oil-hardening, nonshrinking and nondeforming tool steel deposits similar to the oil-hardening graphitic grade are produced by 71M. Deposits are hard as-welded (56 to 60 R_C) and can be used to weld both the annealed and hardened oil-hardening grade. Weld deposits can be softened for machining by pack annealing at 1450 F to a hardness range of 30 to 35 R_C. When applied to the annealed grade, 71M deposits will harden when austenitized at 1450 to 1500 F and oil-quenched.

The air-hardening grade of graphitic steel is best welded with T.G.A. This electrode material is similar to 71M in microstructure and weld deposition characteristics but has higher hardenability, strength and wear resistance. T.G.A. can be hardened to 58-62 R_C when applied to large or small sections, rounds, squares, flats, even when the whole mass is rehardened at 1450 to 1500 F in air. It is thus suitable for welding the hardened as well as annealed air-hardening steel. T.G.A. weld deposits can be softened for machining by tempering for seven hours at 1200 F to R_C 34 to 37.

For water-and-brine hardening graphitic steels, 70W is used and produces hardened deposits of 58 to 62 R_C as-welded. The deposits are similar to 71M in strength and hardness, but are somewhat more

wear-resistant. Pack annealing at 1450 F softens 70W deposits sufficiently for machining operations.

For simple tie-down, tool anchoring or spotting in place, or fill-in of heavy weld craters or holes, it is unnecessary and uneconomical to use the hard as-welded rods. Regular commercial ferritic (low carbon) or the higher strength austenitic electrodes can be employed. For filling in deep holes or craters where peening cannot be satisfactorily employed, ferritic electrodes are recommended. Austenitic weld materials shrink more than the base die metals and high stresses occurring in the heat-affected zone sometimes cause cracking in the graphite-free fusion zone near the austenite base metal interjunction. Solid plugs followed by welding with ferritic electrodes of the A. W. S. E10015 class are more acceptable for build-up of deep holes.

Welding Procedures: Surface preparation requires that cracks be completely removed by grinding. Sufficient metal should be removed to allow a 0.125-inch finished weld deposit. In repairing edge or corner defects, a small step is preferable to a smooth 45-deg angle. On angle fractures, allow for a minimum 0.1865-inch depth. Fractured or cracked units should be ground in a U-shape (avoid sharp corners) as in *Fig.* 2. Repairs can be made by welding with ferritic or austenitic filler electrodes if the crack is not in a working surface. If the crack is in a working face, ferritic electrodes can be used to fill to within 0.25-inch of the surface. Finish welding is done with the appropriate hard as-welded rod. For repairing large surface areas, the surface should be prepared so that finished deposits will be at least 0.125 inch in depth.

Preheating is recommended because it thermally stretches the base metal before welding and it slows down rapid cooling of the weld metals after welding. This reduces shrinkage and cooling stresses, lowers distortion and lessens danger of weld cracking. Preheat temperature is 350 to 400 F, but not beyond 400 F unless the final temper on the unit being welded was higher than 400 F. Since 400 F is the usual tempering or drawing range on graphitic tool steels, a loss of hardness in the base metal occurs if final draw temperature is exceeded during preheating or welding.

Preheating is best done using a controlled furnace or hot plate when possible. On extremely large units, an improvised brick oven can be built and fired by a gas-electric blow torch or high-pressure gas burners. When these methods are not practical, an oxyacetylene torch can be used. Torch preheating must be done slowly for even heat saturation.

Electrodes of the smallest possible size should be used, especially for sharp cutting edges, because less heat input is required. Also, use of smaller electrodes requires more weld passes, giving better control of interpass temperature. Lower welding stresses occur since each pass briefly anneals or tempers the preceding pass. With the smaller electrodes, there is also less chance of creating sear marks and craters, of overtempering the base die metal. Less grinding is needed after welding.

Welding deposition can be started once the die unit has been preheated to the recommended temperature, but must be completed before the die unit is allowed to cool to room temperature.

In the welding of cutting edges, the work should be positioned so that the deposit will flow or roll

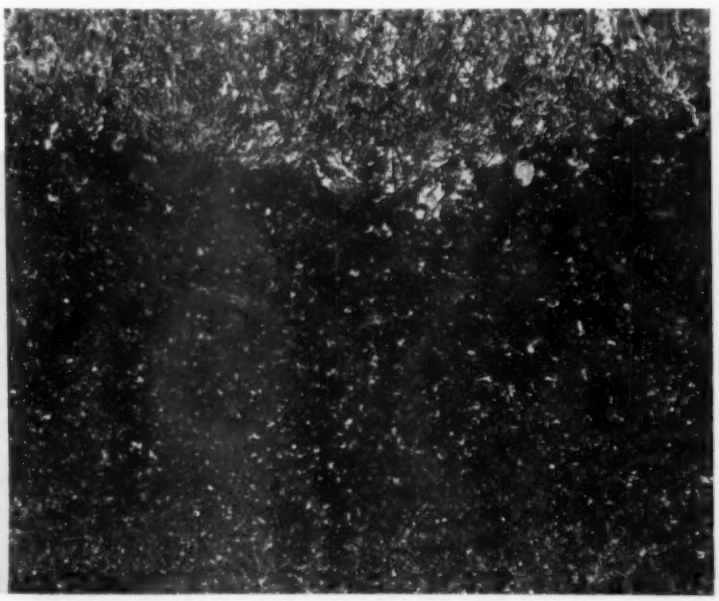


Fig. 4. Typical weld microstructure obtained after postheat at 400 F.

over the sharp edge. In welding deeply damaged cutting edges or drawing and forming surfaces, the damaged area should be filled from bottom to top, using slightly higher amperage on the first few beads than on the finishing beads. In repairing circular parts such as entire cutting or forging edges of draw rings, and female extrusion dies, skip-weld methods should be used to insure even heat distribution and lower stress build-up.

In depositing beads, the work should be arranged so that gravity can roll the deposit back evenly,

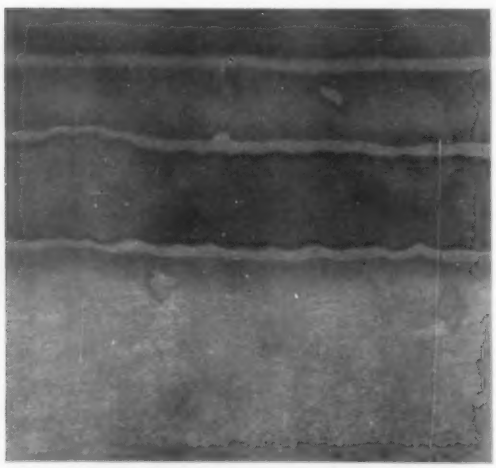


Fig. 5. By using graphitic steel and suggested welding procedures, holes, spalling and cracking types of die damage are repaired.

keeping a continuous top cover of slag to minimize decarburization and oxidation. The travel rate should be slow enough to obtain an even deposit and uniform fusion with the parent metal. The weld metal should be deposited in increments not longer than three inches to allow better control of interpass temperature and to allow for peening of the bead at the appropriate temperature.

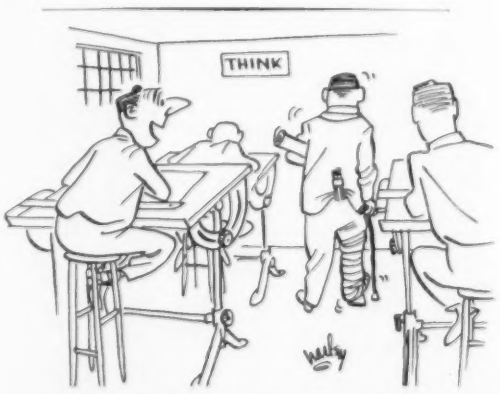
Peening serves as a mechanical method of stress relief to physically stretch the bead metal, counteracting later shrinkage of the weld deposition. Compressive stresses formed by peening neutralize the opposing tensile stresses normally formed during bead shrinking or cooling for both filler and finish beads. To be effective, peening should be done when the bead it at red heat (1000 to 1300 F) so that the metal can be slightly cold worked and extended. At higher heats, peening is less effective as the soft metal is simply displaced. At lower heats, cold working can cause bead cracking. Peened areas should be kept clean by frequent brushing. After cleaning, more lapping beads can be placed.

In filling open holes in hardened dies where more than two or three depths of weldment are required, it is good practice to plug the hole with a high-carbon steel rod or bar. The plug should be inserted from the side opposite the working surface and extend to within 0.25 inch of the working surface. Two layers of plain carbon (ferritic) electrode of the A.W.S. E10015 class followed by finishing beads of the appropriate hard electrode complete the job. Austenitic rods are not recommended for hole filling because the difference in shrinkage rates between the austenitic deposit and base metal can develop cracks in the fusion zone, particularly when it is impossible to peen.

Weld metal deposited by these techniques does not contain graphite in the microstructure, as shown in *Fig.* 3. The weld deposits are thus more susceptible to stress cracking, grind checking and burning than the material being welded. Stresses are lower than on welds on conventional steels due to the stress relieving action of the graphite pockets. Nevertheless, postheating is required on all welds of graphitic steel to minimize grind checking of the deposits.

After the weld metal is depositited, the die unit should be allowed to cool to room temperature and then given a postheat treatment to approximately 350 to 400 F to temper the weld deposit and the heat-affected zone of the base metal. Typical microstructure of a postheated weld is shown in *Fig.* 4. Grind checking seldom occurs in the base graphitic material. Soft wheels are recommended for grinding the weldments.

Using these techniques produces evenly diffused and crack-free weldments on graphitic tool steels. The deposits do not check during normal grinding operations and can be used directly as working surfaces after grinding. Results obtainable are shown in *Fig.* 5. The sample block of *Fig.* 2 with a rounded edge, hole, and simulated crack has been restored to its original condition. Weldability of graphitic tool steels makes repairs and re-use of worn or broken dies feasible, allows changes in designs and permits rectification of errors.



"He insists he slid off his slide rule."

how to get
OPTIMUM PRODUCTION
—from multiple-machine setups

By Roy Mennell*
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Minimum-cost machining conditions for any desired production rate—the optimum number of machines and the best cutting speeds—can be determined mathematically, using a general production function developed by the author.

SELECTION OF OPTIMUM machining conditions has been a frequent subject in the machining literature since World War II, revealing a keen general interest in reducing production costs through mathematical analysis.* The number of possible applications for such analysis, however, is large and many areas have not as yet been developed. One such area is the determination of optimum conditions when the production rate requires the use of more than one machine to perform the same operation. With few exceptions,[8] only single machines have been considered in machine cost analysis. This article shows how to solve for the optimum speed and number of machines for any particular production rate when workpiece material, tool geometry, feed and depth of cut are known.

Maximum Production: Before proceeding with the derivation of the machining production function, it should be noted that there is an absolute maximum production rate, which is determined by the number of machines assigned, as well as by certain machining constants.

Expressing the total time to produce a part (T_p) as the sum of the machining time per part, (T_c) and tool changing time per part (T_d),

$$T_p = T_c + T_d \frac{T_c}{T} \quad \text{.....(1)}$$

where T_c/T is the frequency of tool change per part and T is the tool life.

By expressing both terms as a function of speed (V), the speed for maximum production rate for one machine may be calculated. Given the dimensions of the workpiece and the feed $T_c = L_p/V$, where L_p is the helical distance passing the workpiece. Assuming the relationship from experimental data between speed and tool life is of the form $VT^n = C$, T becomes $(C/V)^{1/n}$. Substituting these expressions into the time equation, T_p is a function of V.

$$T_p = \frac{L_p}{V} + \frac{T_d L_p V^{(1/n)-1}}{C^{1/n}}$$

The minimum time per part is found by taking $\delta T_p/\delta V$ and setting the result to equal zero.

$$V_{\text{max prod}} = \frac{C}{T_d \left(\frac{1}{n} - 1\right)^n} \quad \text{.....(2)}$$

Substitution into the Taylor Equation ($VT^n = C$) gives the tool life for maximum production. Minimum-cost conditions are found by an analysis similar to that given above, but by expressing cost per part as function of machining cost and tool costs.

For comparison, the values for V and T for both minimum cost and maximum production rate are

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*See references 1 through 7 at the end of this article.

Nomenclature

C = constant
L_p = helical distance machined, ft
R = constant
T = tool life, min
T_c = machine time, min
T_d = tool change time, min
T_p = total time per part, min
V = cutting velocity, fpm
X_1 = tool usage, tools per min
X_2 = machine usage, machines per min
Z = production rate (output), parts per min
c = production cost, cents per min
n = constant (exponent)
x = machine and operator cost, cents per min
y = tool cost per edge, cents

of interest. For minimum cost:

$$V = \frac{C}{\left[R\left(\frac{1}{n} - 1\right)\right]^n}$$

$$T = R\left(\frac{1}{n} - 1\right)$$

For maximum production:

$$V = \frac{C}{\left[T_d\left(\frac{1}{n} - 1\right)\right]^n}$$

$$T = T_d\left(\frac{1}{n} - 1\right)$$

where y is tool cost per cutting edge, x is the cost for use of the machine per minute and R is defined as $(x T_d + y)/x$. It can be seen that with a constant number of machines the difference in production rate and cost for the above two conditions will tend to be small when tool cost y is low or machine cost x high.

Production Function: The machining production function describes the output in parts per minute (Z) in terms of the two input variables—machines per minute (X_2) and tools per minute (X_1) and is derived as follows:

The production rate equals the number of machines employed divided by the time per part (T_p).

$$Z = \frac{X_2}{T_p} \quad \ldots\ldots (3)$$

Substituting Equation 1 for T_p:

$$Z = \frac{X_2}{T_c\left(1 + \frac{T_d}{T}\right)} \quad \ldots\ldots (4)$$

It is now only necessary to express T_c and T in terms of X_1 and X_2. If work handling time is ignored for the present, tool usage equals the number of machines divided by tool life plus tool changing time.

$$X_1 = \frac{X_2}{(T + T_d)} \quad \ldots\ldots (5)$$

Here it has been assumed that only one entry is required on the workpiece. If several passes are required the time required to accomplish re-entry can be added to the workpiece handling time as it is constant per part and does not vary with cutting conditions. Solving Equation 5 for T and substituting into Equation 4

$$Z = \frac{X_2}{T_c\left[1 + \left(\frac{T_d}{\frac{X_2 - X_1 T_d}{X_1}}\right)\right]} \quad \ldots\ldots (6)$$

Assuming the tool life relationship ($VT^n = C$) holds over the region of interest and using $T_c = L_p/V$ and Equation 5, T_c becomes

$$T_c = \frac{L_p}{C}\left(\frac{X_2 - X_1 T_d}{X_1}\right)^n \quad \ldots\ldots (7)$$

and therefore

$$Z = \frac{X_2 C}{L_p\left[\left(\frac{X_2 - X_1 T_d}{X_1}\right)^n + T_d\left(\frac{X_2 - X_1 T_d}{X_1}\right)^{n-1}\right]} \quad \ldots (8)$$

To modify Equation 8 to take into account work handling time one can multiply by a constant.

Because a given production rate may be obtained from a variety of combinations of the inputs, the cost of each combination must be known. The cost per minute (c) in terms of X_1 and X_2 is given by

$$c = yX_1 + xX_2 \quad \ldots\ldots (9)$$

The two inputs have dissimilar characteristics. Tools (X_1) have current costs and are infinitely divisible, while machine (X_2) represent capital costs and must have integral values. The coefficient of X_2 appears in Equation 9 as a constant, but it should be noted that its value was obtained by a minimization process,[9] i.e., for various machine lives the constant semiannual outlay stream that has a present value equal to all future outlays for a chain of machines is calculated and the minimum outlay stream is chosen to determine x.

Least-Cost Method: To determine the least-cost method for achieving any desired production rate, one minimizes $c = f(X_1,X_2)$ subject to $Z = f(X_1,X_2)$ i.e., Equation 9 subject to Equation 8. A common method of accomplishing this is to use the Lagrangian multiplier technique. However, the calculations here are tedious and a simpler method presents itself from knowledge of minimum cost tool life. Substituting the minimum cost tool life

$-R[(1/n)-1]$ for T, where $T = X_2 - X_1 T_d / X_1$, into Equation 8, the production rate at minimum cost (Z_m) becomes

$$Z_m = \frac{X_2 C}{L_p \left\{ \left[R\left(\frac{1}{n} \cdot 1\right) \right]^n + T_d \left[R\left(\frac{1}{n} \cdot 1\right) \right]^{n-1} \right\}} \quad \ldots (10)$$

The production rate is now in terms of one variable —X_2. Similarly, the cost equation can be simplified. By making the substitute of

$$\frac{X_2}{R\left(\frac{1}{n} \cdot 1\right) + T_d}$$

for X_1, (from Equation 5 with $R\left(\frac{1}{n} \cdot 1\right)$ substituted for T) Equation 9 becomes

$$c_{\text{min cost}} = X_2 \left(x + \frac{y}{R\left(\frac{1}{n} \cdot 1\right) + T_d} \right) \quad \ldots (11)$$

which is also a function of one variable—X_2.

As an example, consider the case of ceramic machining with a tool-life curve of $VT^{0.5} = 5300$ at $f = 0.0175$, $y = 50$ cents, $T_d = 1$ min, $x = 22$ cents/min, and $L_p = 5800$ ft. These values give a minimum cost tool life ($T_{\text{min cost}}$) of 3.5 min. When these constants are substituted into Equations 10 and 11 and c is solved for in terms of Z, the result is $c = 87\ Z$. The solution is shown in *Fig.* 1.

Graphical Solution: For any production rate desired, it is possible to find c, X_2, X_1. The solution would be complete except for the fact that only integral values of the machines are physically possible. Therefore, only the points on *Fig.* 1 represent feasible solutions. To determine the optimum combination of machines and tools for any level of production, one must construct a figure such as *Fig.* 2. *Fig.* 2 is a graphical solution for Equations 8 and 9 using the ceramic constants previously mentioned. The intersection of the minimum-cost line and production lines correspond to the solution given in *Fig.* 1. The maximum production line is shown and represents the maximum production rate for a given number of machines.

It can be seen that for any level of production there is a multitude of combinations of machines and tools. Each of these combinations can be obtained for a different cost and the problem is to select that combination which results in a minimum cost. On *Fig.* 2 this is equivalent to proceeding from the origin parallel to the isocost lines until the appropriate isoquant is contacted. If, as is the general case, the point of contact does not represent an integral number of machines, one must continue proceeding parallel to the isocost lines until the first point on the production lines that calls for an integral number of machines is reached.

It is possible, then, for a production planner to schedule an assigned production rate from a figure similar to *Fig.* 2. He first finds X_1 and X_2 (taking into account work handling and other constant nonmachining time) and therefore knows how many machines to assign to the job and what the tool consumption rate will be. With this information he can solve the following equation:

$$V_{opt} = C \left(\frac{X_1}{X_2 - X_1 T_d} \right)^n \quad \ldots (12)$$

for the appropriate cutting speed at which to set the

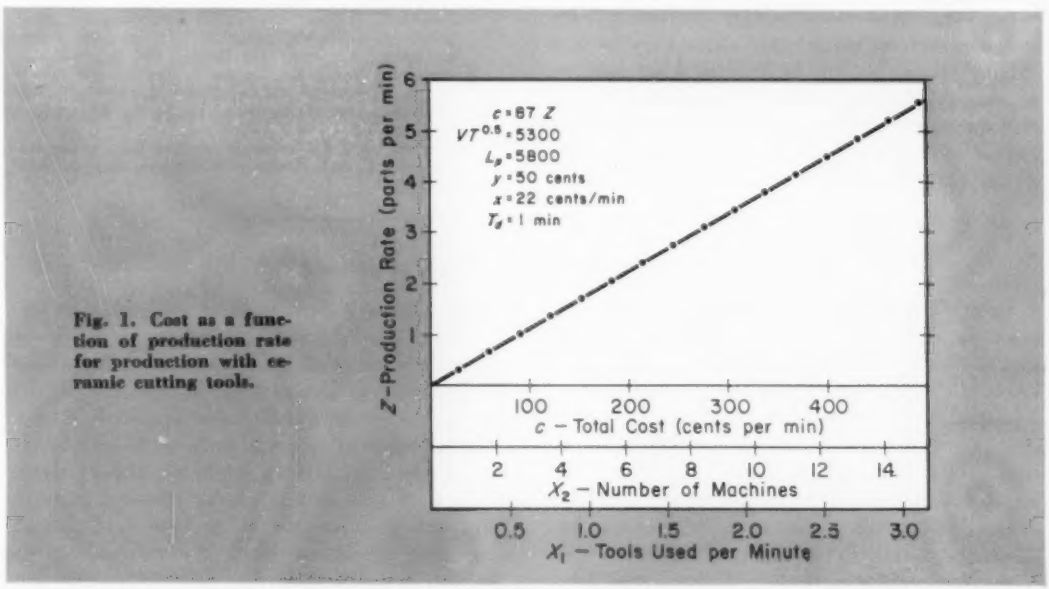
c = 87 Z
VT^0.5 = 5300
Lp = 5800
y = 50 cents
x = 22 cents/min
Td = 1 min
Z – Production Rate (parts per min)
c – Total Cost (cents per min)
X2 – Number of Machines
X1 – Tools Used per Minute

Fig. 1. Cost as a function of production rate for production with ceramic cutting tools.

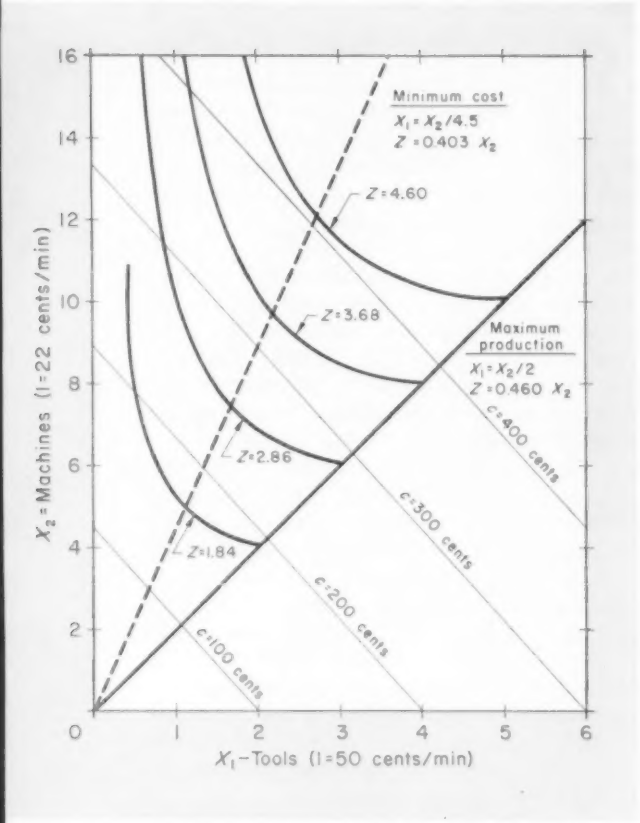

Fig. 2. Ceramic machining production function.

machines (Equation 12 is simply the tool life equation solved for V with T in terms of X_1 and X_2 from Equation 5).

For purposes of comparison, an arbitrary rule for tool life, such as ten minutes and a required machining production rate of 3.68 parts per min can be assumed. On *Fig.* 2 this is equivalent to saying that the cost and conditions present at the intersection of the 3.68 production rate line and the $X_1 = X_2/11$ line (Equation 5) must be accepted. This intersection specifies fourteen machines with a 380-cent machining cost.

The optimum conditions (intersection of the 3.68 production line with the minimum-cost line) for this example are ten machines, a tool life of 3.5 min with a resulting machining cost of 325 cents or a saving of seventeen percent.

No arbitrary tool life will be accurate for a variety of applications. Because the economic tool life equals

$$\frac{xT_d + y}{x}\left(\frac{1}{n} - 1\right)$$

tool changing time, machine cost, tool cost, and Taylor exponent (n) all affect the optimum tool life. It is interesting to note that if x is increased or y or T_d decreased, the economic tool life approaches the maximum production rate tool life of

$$T_d\left(\frac{1}{n} - 1\right)$$

Inversely, milling applications where y is high, multitool applications where T_d is high, or inexpensive machine applications where x is low, require machining conditions further removed from maximum production rate conditions.

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Computers Simulate Blast Furnaces

Electric computers are now being used to simulate the operation of actual blast furnaces in studies aimed at increasing productive capacity at low cost. The success of these studies was recently described in a paper by A. L. Hodge, associate manager of gas process development for Linde Co., Div. of Carbide Corp. Tested on a number of actual furnaces, comparison of the computer predictions with results measured in the furnaces has shown the method to be extremely reliable.

New steelmaking methods and rising costs have made necessary the increased production of iron and ferroalloys for the steel industry at the lowest possible investment. Results of the studies of furnace operations indicate that, through the addition of oxygen to the metallurgical processes, production increases of as much as 25 to 30 percent can be obtained in existing furnaces. Other interrelated conditions, such as thermal efficiency and control, can be improved by changes in the stable operating conditions when the outcome of the changes is predictable.

Calculating Life of Milling Cutters

By C. A. Hadley*
Senior Process Engineer • Harley-Davidson Motor Co. • Milwaukee, Wis.

USING MILLING CUTTERS most economically requires that the proper machining conditions be selected. A determination of factors affecting tool life and thus tool change frequency is essential. The nomograph presented here will serve as a guide in deciding on the machining conditions to be used. In addition to showing feeds and speeds, the nomograph takes into consideration the type of cutter used and the depth of cut. The feeds have been bracketed to delineate ranges beyond which feeds would be excessive when they are increased to compensate for speed decreases.

While a 60-minute tool life is used as the basis for the nomograph because of the cost of tearing down a setup to change cutters, a 30-minute tool life should be used with cutters with indexable inserts. The values presented in the nomograph cover most normal operating conditions. Feeds and speeds may have to be altered to meet unusual situations such as frail castings, difficult holding problems or weak or poorly supported arbors or cutters.

*Senior member ASTME Milwaukee chapter.

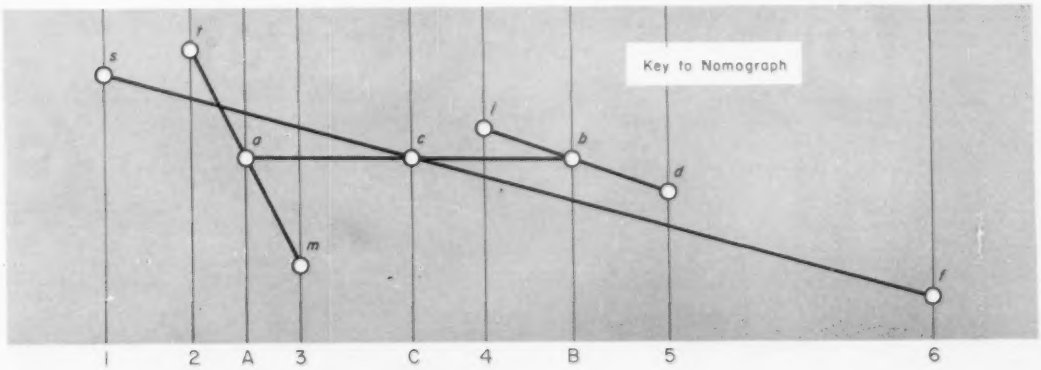
To determine feed and speed with a preset tool lfie, first establish point *a* on Scale A as shown on the key from appropriate values of tool material t and workpiece material *m*. Next, determine a point *b* on Scale B from form depth of cut *d* and tool life *l*. Connect points *a* and *b* intersecting Scale 6 at *c*. Point *c* connected with feed *f* will give a resulting cutting speed *s* on Scale 1. When connected with a given cutting speed value, point *c* will give the desired feed on Scale 6.

To determine tool life, point *a* is established from *t* and *m* as before. Point *c* is established from values of *f* and *s*. Point *b* is found by connecting *a* and *c*. Determine tool life on Scale 4 by connecting *b* and *d*.

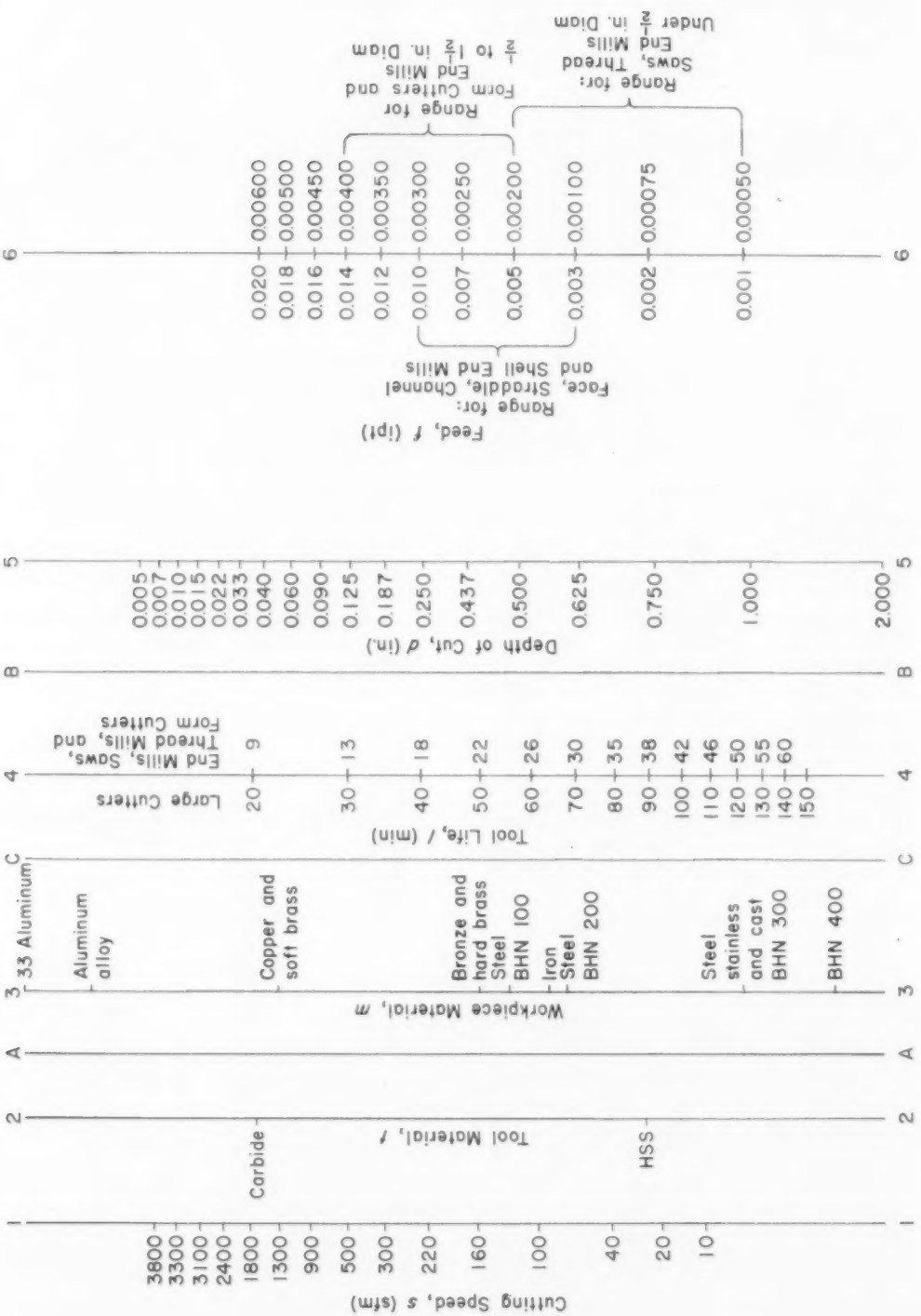
References

1. *Brown & Sharpe Cutter Lore*, p. 78 to 84
2. *National Tool Co. Catalog*, p. 83

Note: **The nomograph is based on machining with coolant. If no coolant is used, apply a 0.8 factor to the tool life. Also the chart is based on good tool practice with the proper grade of carbide, using helical or staggered tooth cutters wherever possible and climb milling if conditions permit.**



Nomograph for Determining Life of Milling Cutters



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ASTME PROFILE

An Anchor Man

When Alfred J. Weisbecker doodles, he draws straight lines, anchors and rudders.

In his work he acts as a rudder for the billion-dollar Industrial Production Equipment Branch of the U.S. Bureau of Ships. In his affiliation with ASTME he is an anchor man in Washington chapter. As for the straight lines, they somehow express the man. . . .

Al, 63, has managed to combine an ocean-wide knowledge of machine tools with an unashamed patriotism and love of the Navy. He might be called Davy Jones' locksmith; he steers the administrative policies and procedures that govern one billion dollars' worth of equipment, of which some $220 million represents machine tools located in the country's 11 naval shipyards and some 30 miscellaneous industrial activities.

In careful, erect phrases he declares, "For months during World War II, I went around in thick green circles with the Navy in the South Pacific. Now I travel in straight lines for the Navy—if for no other reason than that the halls in Washington are straight, and interminably long. . . .

"Seriously, I regard my job as a challenge. And I'll defend the ability, talent and progressiveness of the Navy I come in contact with—the Navy yard personnel and equipment—against the criticisms of those who regard everything military as goldbrick."

Al has always been a sucker for volunteering. Within a few days after the Korean conflict became an established c r i s i s, Commander Weisbecker, USNR, traveled again from his native New York City to Washington, to the Navy Department, where he requested active duty. He offered to turn his machine tool dealership over to a junior partner, and volunteered for the third time in his life to serve in the armed forces. He was assigned as director of the industrial tool engineering division of BuShips, and is still there—as a naval officer until his retirement in 1955 and as civilian expert since.

Not too long ago Al faced a test that is apt to confront men of responsibility along the Potomac—he had to go up on "the Hill" to testify before a Senate subcommittee. Appropriately for a Navy man, he passed with flying colors.

"I want to say," said the subcommittee chair-

Conferring on specs for shore establishments and ships afloat are John F. Thompson, equipment specialist; Weisbecker and his assistant, Adrian G. Sira; and Robert J. Carrodus, production specialist. All are members of ASTME, Weisbecker and Carrodus being the new first and second vice chairmen in Washington.

on the Potomac

By M. L. Stone
News Editor

man, Senator Edward J. Thye of Minnesota, to Weisbecker and his superior, "that you have given us an excellent report. I think this report assures us that the Navy has certainly proceeded not only as to inventory but also to package requirements in order to ascertain what the needs are. I am very happy with this report."

Weisbecker's report to the senators, who were investigating the health of the machine tool industry as one of the pillars of defense, covered his introduction of a machine tool replacement program in BuShips. As a result of the hearings, he was told to give his presentation for the benefit of other bureaus and military departments. Wide publicity culminated within a few months in adoption of his replacement program by the Department of Defense. By directive each department in the military was ordered to establish such a program and budget annually for the replacement of its obsolete machine tools on an orderly basis, using Weisbecker's formula for determining obsolescence.

Al's five-section, 50-man staff had found in studies that the bureau was spending only one percent of inventory annually for replacing obsolete equipment, whereas progressive industrial management, recognizing the competitive advantage of modern machinery, set aside from 8 to 15 percent annually for replacement. Exhaustive analyses pinpointed the bureau's exact needs both for mobilization and for peacetime requirements. Citing the machine tool industry's experience during the World Wars, Weisbecker told the senators:

"It is simple logic to phase our replacement of obsolete machine tools during peacetime, thus deriving the obvious economic benefits of high performance, modern tooling and at the same time assisting our machine-tool industry to remain healthy and prepared to expand rapidly and efficiently should mobilization come. This would help to reduce the tremendous backlogs of machine tool orders should a shooting war start."

Another bureau program which is credited to Weisbecker is a continuing series of conferences of shipyard and fleet personnel and industry representatives. The most recent tools conference was held at the Norfolk Naval Shipyard, in which 77 naval shipyards' leaders and 40 people from industry participated; in addition, 190 representatives offered 95 exhibits of new equipment and techniques.

Al Weisbecker opens a door to his offices in the austere building of the Bureau of Ships. As head of the Industrial Production Equipment Branch, he supervises a staff of 50 that keeps tabs on a billion dollars worth of equipment in all the BuShips' activities equipment at naval shipyards.

Al's machine tool career began in 1912, with the Vandyck Churchill company in New York. Many years followed as manufacturer's representative and as partner and owner of machine tool dealer firms. He served as a master engineer in the Army in the first war. From 1942-44 he headed the Navy Ordnance Bureau's machine tool section and in 1944-5 he served in the Southwest Pacific, terminating his tour as assistant fleet maintenance officer afloat, Subic Bay, Philippines.

A few years ago he found an organization that rivals even the Navy in claiming his allegiance. That organization is the ASTME.

Last year he served as program chairman of Washington Chapter 48. This last spring he was installed as first vice chairman.

With men like Al at the helm, the chapter should continue to steer an even course.

Members in the News

Arthur F. Eskelin

A. H. Schott

ARTHUR F. ESKELIN, Los Angeles chapter, has been appointed Pacific regional manager for the industrial controls section, Bendix Aviation Corp. For the past 20 years Eskelin has been research engineer with the Northrop Corp., specializing in metalcutting and numerical controls. In his new position he will be in charge of sales and applications of Bendix numerical control systems for machine tools in western states. He will headquarter at the new Bendix offices in Beverly Hills.

The Ohio Crankshaft Co. announced the election of A. H. SCHOTT as vice president. A member of Cleveland ASTME chapter, Schott served as supervisor of inspection for The Hickok Electrical Instrument Co., of Cleveland before joining Crankshaft Co. in 1941 as supervisor of inspection. Since that time he has filled a number of positions as chief process engineer, master mechanic and factory manager. In 1956 he was appointed general manager of the company's crankshaft and camshaft division, which he will continue to direct.

Two members of ASTME served as moderators at a recent two-day Production Machine Tool Hydraulic Conference in Detroit. At left is Nevin Bean of Detroit chapter, manager of the tank study group, Transmission and Chassis Div., Ford Motor Co. Right is R. C. Montanus of Springfield, Mass., chapter. Montanus is chief engineer for the Springfield Machine Tool Co. The conference, sponsored by Vickers, Inc., drew 120 representatives from user and builder groups, accessory suppliers, and educational institutions. One of the speakers, Robert R. Thoren, of Vickers, is an ASTME member from Rockford. Alan Mattison, NMTBA president, was keynote speaker.

Punch Products Corp. has announced the appointment of ROCCO L. STEFANO, Buffalo chapter, as general manager. . . . Size Control Co. announced the appointment of F. L. MILLER of Dayton chapter and HOWARD MCNEAL of Cedar Rapids chapter as representatives servicing their respective areas. . . . JESS N. MCCOMBE of Milwaukee chapter, a veteran tool steel salesman and district manager in Milwaukee, has been named by the Vanadium-Alloys Steel Co. to serve on the staff of their western district sales office in Chicago. He will also handle accounts in the Milwaukee area.

Double A Products Co., a subsidiary of Brown and Sharpe Mfg. Co., has appointed JOHN PIPPENGER, director of sales. Pippenger is a member of Ann Arbor chapter. . . . DONALD F. DAVERN of Tucson chapter was named project manager of industrial control systems for Hughes Aircraft Co. He will direct the company's expansion in the field of numerical machine tool controls. A veteran of 18 years in industrial management and production engineering, Davern has been manager of planning at Hughes' Tucson missile manufacturing plant. He was formerly with North American Aviation, Inc., and AiResearch Mfg. Co.

Heald Machine Co. has appointed HARTWELL G. HOWE vice president and general manager. A member of Worcester chapter, Howe has served Heald Co. in various sales and supervisory capacities since 1939, excepting for a period as general manager of the J. H. Ryder Co., Toronto.

S. A. CAPPON of Cleveland chapter, manager of the screw product division of the National Acme Co., has been elected chairman of the National Screw Machine Products Association for the year 1960-61. He is also chairman of the Committee of Technical Research and Standards of the NSMPA.

—Photo courtesy Jackson Citizen-Patriot

Quality control in the classroom means quality control in tomorrow's industry. Students get special training in metallurgy and related topics in Jackson Junior College's outstanding technology program. Instructor Herbert Howell (left) directs Larry Adkisson's examination of a metal sample as John Wild, in the background, tests metal hardness.

Jackson Chapter Helps Fill a 'Talent Gap'

EDUCATION is everybody's shibboleth these days. From overuse the word threatens to become hollow, or else to become a never-never ideal with pi-in-the-sky connotations. Like the weather, everybody talks about it, but unfortunately not everybody does something about it—except perhaps in Jackson, Mich.

In the appealingly average city of Jackson one encounters a refreshing example of education that is perceptual rather than entirely conceptual. Education has been tailored to fit reality there.

A down-to-earth program at the Jackson Junior College is successfully turning out talent to fill a gap in industry between the professional engineer and the skilled craftsman. The program fits hand in glove—or hand in work-glove—with the desires of the community's youth and the needs of the community's industry. And a large measure of the credit for encouraging this new approach must be assigned to Jackson Chapter 87, ASTME.

$3000 Educational Fund

The chapter has been acutely education-conscious almost since its inception in 1951. A striking demonstration of its dedication is seen in the fact that the $3000-plus education fund of the 223-member chapter is second in the whole Society only to one other chapter's, with a thousand members.

The Jackson chapter sponsors yearly scholarships, from its affiliate membership dues, totaling up to $1000 for students in the JJC industrial technology school. With 18 affiliate members now, the chapter has set a goal of 100 percent representation from area industry. In Jackson, that goal is logically attainable. . . .

Program Sparks Membership Gain

The Jackson education story began in the fall of 1956.

Since then, membership growth has been an interesting by-product of the chapter's involvement in community educational efforts. The chapter's work in education has served as a uniting force, a rallying point, a reason-for-being.

Significantly, the membership of the chapter rose from 87 to nearly 200 in the first year after the tool engineers brought the community's educational needs into focus.

As related by Education Chairman John V. Kopplin, a registered engineer himself and closely identified with education through his father's long affiliation with public schools, the chapter members discerned a "talent gap" in local industry and determined to do something about it. They took the problem to local educators.

New manufacturing techniques and new knowledge, they told the school men, were creating a wider disparity between professional engineers and journeymen. A new breed, the technician, was increasingly needed, and he was in short supply.

The tool engineers found a sympathetic and intelligent audience. The educators immediately tagged the problem as worthy of study and action. They felt that it was a spot for the practical applica-

tion of education and a natural for the community college.

The need was later defined graphically by Harold Matthews, director of vocational instruction for the city's public schools:

"Once there were men who wore white collars and men who wore blue collars. One group worked at desks and the other at machines.

New Class of 'Sports Collar Workers'

"But today a need has opened up for a man who works largely at a desk or drawing table, but doesn't have to be so formal that he wears a white collar. This is the technician we're training."

A writer for the *Jackson Citizen-Patriot* carried the symbolism a little further and dubbed this new target of education as the "sports collar workers."

A brief but intensive survey to determine the feasibility of establishing a two-year program in tool engineering at the community college level was begun by the ASTME members in November 1956, with the cooperation of the Jackson public schools. Heading Jackson's Office of Vocational Education at that time was Matthews' predecessor, Gilbert E. Seeley, later to become national education director of ASTME.

A tool engineering curriculum was set up. Equipment was installed in basement classrooms. Part-time instructors drawn from local plants—"keeping the program in touch with reality," as Chapter Education Chairman Kopplin described it—were released by their companies for classroom assignments. Classes started in the fall of 1957.

Committee Undertakes Broad Study

During the planning for the tool engineering curriculum, Society members and industry and education leaders decided that much more should be known about technical education in general and about the community in which the programs would function. After rather informal discussions with various organizations and industries during 1957, a formal Committee for Technical Education at the Community College Level was established in 1958. The committee held weekly meetings.

This advisory committee of seven included Kopplin, representing ASTME. It set out immediately to investigate the needs for technicians in Jackson, the numbers and types of technicians required, and the kind of educational program necessary to train such experts *specifically for the city of Jackson and its environs.*

Significantly, the committee added that "the results of the study are equally applicable to other localities." The resultant program at JJC has since served as a model for many other community-oriented educational institutions.

"This committee believes," read its report, "that the technician is becoming an indispensable link between the skilled worker and the engineer. This is true in every phase of the industrial world, also true in the service area. The actual translation of dreams to plans, and plans to operation, the performance of technical processes and services, are all fields in our modern economy in which technically trained persons will find many opportunities.

"The needs of the community will determine to an extent the kinds of technical education made available. However, it is of at least equal importance that the needs of the young people and adults of this community will determine the kinds and types of programs in technology that the college should offer. . . ."

The report emphasized that the programs should not be the same as the programs at the industrial education or apprenticeship level, where the educational instruction is directed seriously toward a skilled trade.

Three Categories of Technology

The committee concluded that the broad areas of technology in the Jackson area should comprise three categories: industrial, power and electronics. It recommended that curricula in these fields be arranged to provide a two-year post-high school training program which should have its own objectives rather than be a part of a four-year program in professional engineering.

This new type of education in Jackson has been greeted enthusiastically by both businessmen and students. Manufacturers are delighted to support the program because they find themselves in the enviable position of being able to hire much-needed technical help from the local labor and education pool.

The industrial community was polled by the committee on how many technicians each plant had on its payroll, and on the ratio of technicians to engineers. Many of the manufacturing executives replied that the ratio was now two or three technicians to one engineer. Several of them predicted that the ratio would increase to five or more to one, as automation is implemented and as the employment picture otherwise changes.

Expect Need to Soar in Sixties

To still another query, on what the various local companies' anticipated needs will be for technicians, this reply was typical:

"Our company and similar companies expect our need for this type of person to start to increase in 1961 and to continue for some years to come.

"As the labor force in industry changes, it is expected that the need for skilled personnel in the tools and the need for technically trained personnel at the subprofessional level will increase not less

than 25 percent. The need for laborers, production workers and unskilled personnel will continue to decrease in the community."

The project is now booming and is already looking for more lab space. A new science and industries building will soon relieve the cramped program. Fifteen percent of the 1000 or so full-time students at JJC are enrolled in technical education, 75 of them in tool engineering.

In one lab at West Intermediate School, one of the Jackson public institutions, students are busy machining parts identical to those turned out in local industrial shops. Half the cost of the extensive machine shop equipment was paid by government funds available on a matching basis through the National Defense Education Act. The program has been approved under Title VIII of the 1958 act.

Course offerings include logic and reason, math, basic writing and communication skills, psychology, physics, drafting, metallurgy, metal processing, design, industrial electronics, electrical systems. The 64-credit-hour curricula require 16 hours in the major field option, 16 in related subjects, and 32 in general education.

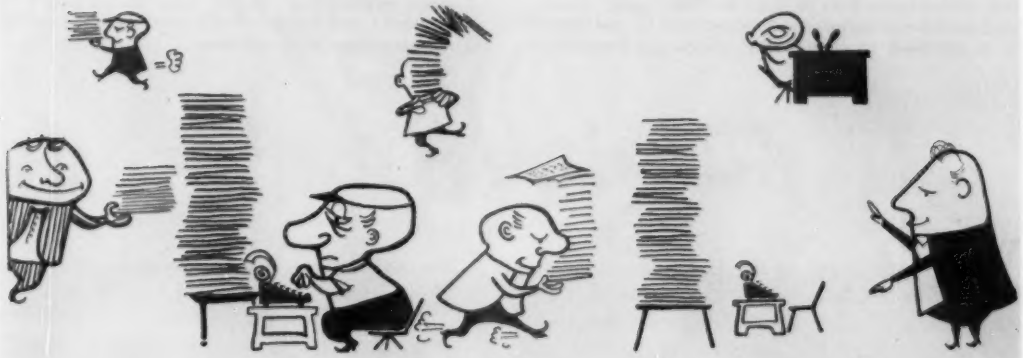
Ingredients of Unusual Education

Kopplin, who is proud of his chapter's role in the educational adventure at Jackson, is also anxious to keep the record straight on the basic purposes of the program.

"This is not education as usual. These programs are not short cuts to engineering, but are programs with their own identity and based on specific objectives.

"These programs are *experience*, powered by *interest*, and guided by *purpose*."

The ASTME members help furnish all the ingredients.



A Report on Report Writing

AN ASSOCIATE PROFESSOR of English who has endured 22 years of teaching report writing to engineers reported on some of his more excruciating experiences at the recent Purdue on-campus conference.

Prof. V. E. Gibbens of the Purdue faculty told the tool and manufacturing engineers that most of the reports he has encountered fall into one of these "don't" categories:

Grab-bag—a mixed-up potpourri of pertinent and impertinent information.

Poker-faced—wherein the writer somehow manages to assign a monotonous sameness of interest to both important and unimportant matters.

Smokescreen, or camouflaged—which Gibbens labeled the "standard progress report form for people who have no progress to report."

Sherlock Holmes—in which the writer tantalizes the reader (less skillfully than A. Conan Doyle) and saves everything until the end.

How-many-hairs-in-the-horse's-tail type—a self-explanatory category in which the writer flagellates his reader with unimportant details. Just the opposite of such famous reports of the past as "Sighted sub—sank same" and "I came; I saw; I conquered."

Call-a-spade-by-any-other-name-report—otherwise known as beating around the bush. Gibbens read a version of this type (which is too long to reprint here), and then summarized the version with four simple Anglo-Saxon words: "Let there be light."

The professor offered one "do" for engineer-writers: get to the point. If possible, he said, use words that evoke images.

A round-table discussion preoccupied four key men at the Purdue on-campus conference during the luncheon intermission. Left to right are Dale Long, attending his first on-campus conference since he was sworn in as national president; Roy Erickson, immediate past president of the Indiana-Kentucky and Western Ohio Council; Richard W. McDowell of Purdue's industrial engineering faculty, who chairmanned the conference; and Vincent Spahr, new president of the sponsoring council of chapters.

Purdue Conference

WHEN REGISTRANTS at the eighth annual Tool and Manufacturing Engineers Conference at Purdue University toured the machine tool labs, they saw a spectacular demonstration of ASTME in action.

Society member and graduate student George McCowan, one of last year's winners of the ASTME's $700 International Education Awards, was running tests on severe interrupted cuts with ceramic tools at a somewhat fierce feed rate of 2000 surface feet per minute. McCowan has just completed his investigation of the tool life of ceramics, under the supervision of Prof. Orville D. Lascoe, and a thesis on his findings is forthcoming.

Another example of creative engineering viewed by the conference visitors was a demonstration of vibration isolation. A press was operating at 1000 strokes per minute without transmitting vibration to the floor, and a young man was gathering data for a doctoral thesis.

Other Student Chapter 6 demonstrations defined the process of explosive forming and showed how radioisotopes are used to measure tool wear. In addition, a number of industrial exhibits had been set up for the 132 visiting engineers and 25 off-campus engineering students who came to Purdue.

The radioisotope exhibit expressed the major emphasis of the technical sessions that followed. After welcome speeches by Conference Chairman R. W. McDowell of Purdue's industrial engineering department and Associate Engineering Dean H. L. Solberg, and after an opening paper on "Report Writing" (reported on the preceding page of this magazine), the Saturday audience heard seven papers on the theme, "Scientific Applications in Tool and Manufacturing Engineering."

Emphasis on Nucleonics

Two of the papers, plus the after-dinner speech that evening, dealt with nucleonics. Dr. B. G. Dunavant, Purdue assistant professor of health physics, discussed principles of radiation safety as applied to industry. He cited the mushroom growth of radioactive isotopes from 86 users—only 18 of them industrial—in 1946, to over 5000 users—1600 of them industrial—at the end of 1959. With the help of a glorified Geiger counter and other stage paraphernalia, Dunavant demonstrated the penetration power of alpha, beta and gamma rays, and described how time, distance and a shield may be used to promote safety.

A bionucleonics expert, Dr. W. F. Bousquet,

summarized the applications of radioisotopes. Nuclear technology, he said, is currently saving $500 million a year for industry. Bousquet's department head, Dr. J. E. Christian, elaborated on peacetime applications of the atom at his dinner address, emphasizing humane utilization in the fields of medical diagnosis and therapy.

Other papers covered vibration isolation of high-speed presses by Dr. P. W. Curwen, General Electric Co.; metalcutting methods by E. J. Krabacher, The Cincinnati Milling Machine Co.; impact forging by Kenneth Packer, Danly Machine Specialties, Chicago; numerical control by William Bently, Cincinnati Milling; and benefits derived from carbide as a design material, by James M. Galimberti, Kennametal, Inc.

ASTME President Dale Long reported on "things National can do that chapters can't" at the dinner meeting. Mrs. Long was one of 30 wives who accompanied their husbands to the Purdue conference.

The sponsoring Indiana, Kentucky and Western Ohio Council of 16 ASTME chapters recognized the contributions of two of its past leaders, presenting plaques to D. A. Chambers of Fort Wayne and Roy Erickson of Indianapolis. Vincent Spahr of Lima is the 1960-61 president.

Other visitors included National Education Director Gilbert Seeley, toastmaster at the luncheon session; and Chairman Carl A. Darger of the National Finance Committee, toastmaster in the evening.

Purdue Professor to Poland

Soon after the Purdue conference ended, Professor Lascoe left for Poland to represent the U.S. Department of Commerce at the International Trade Fair in Poznan. His assignment was to help set up and operate the exhibits at the American pavilion during the show, June 12-16, and to evaluate foreign exhibits for the department.

Lascoe's tour was to include plant visits in Switzerland, Germany and France after the Poznan exhibition closed.

A former member and consultant of the National Education Committee, Lascoe is the faculty adviser of Student Chapter 6.

Shows ASTME in Action

One of the many tool exhibits at Purdue holds the rapt attention of a foursome during tour of the machine tool laboratory. That's Carl Darger (second from left) getting the feel of a vibratory feeder. The new chairman of the National Finance Committee acted as toastmaster at the conference dinner.

First Seminar at Twin Cities

TOOL AND MANUFACTURING engineers in Minneapolis-St. Paul borrowed a page from National's book in presenting the first seminar of the Twin Cities chapter's 23-year history recently.

Lured by a brochure which duplicated the National Education Committee's eye-catching leaflets for its Creative Manufacturing Seminars, over a hundred Twin Cities engineers and students showed up for an all-day study of metal-forming. The scene was a downtown Minneapolis hotel.

In addition to borrowing the theme from National —"Metal Forming for Tomorrow's Manufacturing" —the chapter followed the counsel of National Education Director Gilbert E. Seeley in planning the seminar. Seeley's assistant, J. Douglas Mathieson, attended the sessions.

But similarity to the NEC programs ended there. The five speakers on the Twin Cities agenda were the chapter's choices; and the audience was mostly the chapter's own.

A rousing climax to the technical program was the talk by an old-timer, Stanley R. Cope, on "Solving Difficult Deep-Drawing Die Problems"

Cope, president of the Acme School of Die Design Engineering at South Bend, Ind., and a widely known consultant in the field, declared that it costs manufacturers a woefully high average of $100,000 in mistakes alone to train a die designer.

"Many people, including myself," he averred, "are prone to disguise their lack of know-how. They call their costly mistakes 'research and development work.' "

In discussing this $100,000 club that keeps adding new members because of the shortsightedness of management, Cope gave the results of surveys which his people compile every third year on deep-draw die problems that they encounter. These surveys, he said, assign 63 percent of the blame for die mistakes to poor designing. Another 17 percent stems from poor diemaking—poor radiuses, etc.; 11 percent of the problems can be traced to the process engineers; 3 percent to poor metal; 2 percent to incorrect choice of lubricant; one percent to presses; and one percent to "impossible" or unworkable designs.

Cope, a veteran speaker before ASTE groups, noted that his seminar appearance was his first talk to the Twin Cities chapter—and his first talk to any chapter under the new ASTME label.

Seminar Chairman Loren Blanchar, past chairman of the chapter and head of the machine department at Dunwoody Industrial Institute in Minneapolis, asked the registrants to vote on whether to allow Cope to talk five minutes into the scheduled question-and-answer period. The audience voted yes. Cope took 10 minutes.

Electrical engineer Joseph Montgomery of the Elox Corp. of Michigan talked on "Electrical Discharge Machining of Stamping Dies and Cavities." The technique has now penetrated 37 industries in this country, he said. Some 700 companies are using the process in tooling and production.

"EDM is progressing so rapidly, in fact, that any company using the technique is almost forced to maintain a central clearinghouse for information," he said.

Among tooling applications in which Montgomery claimed appreciable savings with EDM are stamping or blanking, cold-heading dies, compacting and extruding dies, forging or cavity dies, and injection molding dies. Advantages of electrical discharge machining in die work he listed as its ability to make odd-shaped holes without sectionalizing, and to cut hard-state metals as well as soft.

"The revolutionary technique makes metal forming for today's—not tomorrow's—manufacturing a reality," he concluded.

Robert C. Burgess, vice president-manufacturing, Burgess-Norton Mfg. Co. of Geneva, Ill., spoke on the tooling and production applications of powder metallurgy. He characterized the process as the only one in which the strength of the part is established after the shape of the part has been formed. Citing Incan and Egyptian precedents for powder metallurgy, he described the blending, compacting, sizing, coining and infiltration operations that make up the complex modern technique. Sintering is basic, he said, and its proper control is the major key to successful powder metal production.

Characteristics affecting the formability and use of carbon sheet steels were discussed by P. A. Reynolds of the Service Metallurgy Dept., U.S. Steel Corp. The first speaker, Herman Flaum of the Cleveland Cap Screw Co., described "Chipless Production by Cold Heading," featuring a film of a giant 200-ton, 1¼-in boltmaker in action.

Members of the Chapter 11 seminar committee were Roy Groves of Dunwoody Institute, chapter education chairman; Harland Benson, Toro Mfg. Co.; Gerald Oppel, Barrel Finish, Inc.; Arthur Stockwell and Orville Wineland, Minneapolis-Honeywell Regulator Co.; and Alf Eidsvoog, Minnesota Mining & Mfg. Co. George Minarik is chapter chairman.

chapter news

Harry B. (Doc) Osborn, past president of ASTME and district manager of the Tocco Div. of the Ohio Crankshaft Co., was guest speaker at the April meeting of the Sydney, Australia, chapter. Osborn, who headed the Society during 1955-'56 term, addressed a capacity crowd on the advantages of the induction heating process.

Sydney Installs Officers, Hears Past President Osborn

SYDNEY—Chapter 144 devoted its March meeting to the installation of new officers. The Australians governing this ASTME group for the coming year are F. O. Walker, chairman; J. B. Finlay, first vice chairman; K. Edensor, second vice chairman; D. Corbett, secretary; and R. Barter, treasurer. Eight committee chairmen officially took over their posts at this same meeting.

Sydney's April gathering, which was conducted at the Australian Institute of Builders Hall on the 20th, featured a talk by ASTME Past President Harry B. (Doc) Osborn. The district manager of the Tocco Div. of the Ohio Crankshaft Co., Osborn addressed the group on the subject of "Induction Heating."

Besides his technical discussion, Osborn gave the Australian members some inside information on the work that is going on in the Society back in the United States and especially at Society Headquarters in Detroit. *—George J. Moulang*

Chattanooga Chapter Joins Society in May Ceremony

CHATTANOOGA—In enumerating the benefits that accompany membership in ASTME, President H. Dale Long told some 90 members of the new Chattanooga group that the Society provides a means of keeping up with latest manufacturing techniques. This enables plants employing ASTME members to compete and prosper. And in turn, prosperous industries mean prosperous communities, Long said in a statement directed at the civic dignitaries present at the chartering.

Long proceeded to give the history of the Society he heads at this May 25th gathering. He told of the various functions it performs in order to fulfill its goal which is "to advance the knowledge and practice of manufacturing know-how." These functions, he said, include publication of a monthly technical magazine and a number of handbooks and technical papers, and staging its annual tool show, considered the best of its kind. The Society's work toward introducing tool and manufacturing engineering courses to colleges and universities has had gratifying effects on this country's educational system. And ASTME-sponsored research programs are now in progress across the nation.

Long, in his first official duty since taking over the presidency in April, installed the officers of Chapter 167 before an audience which included National Vice President Frank Ford, Membership Committeeman E. M. Ketchie, and Gary Woditsch of the ASTME public relations staff. Those Long installed were George Richardson, chairman; C. T. Vigus, first vice chairman; M. L. McGregor, second vice chairman; C. A. Towey, secretary; and Joe Milburn, Jr., treasurer.

Muskegon Wins Plaque For Membership Gains

ST. JOSEPH, MICH.—Muskegon Chapter 111 won the third annual membership award for registering the largest gain during the past year among the

four ASTME chapters in western Michigan. Muskegon's chairman, J. F. Reddam, received the plaque in behalf of his chapter at a joint program here.

Making the presentation was the originator of the membership derby, C. A. Elzinga, area membership captain from Kalamazoo. Elzinga noted that the Muskegon chapter not only led in senior member gains, but also launched a 22-member student chapter at Muskegon Junior College.

John Pridgeon of the National Membership Committee rallied the chapters to the theme that "ASTME's life begins at 40,000."

Some 120 members from the host Benton Harbor-St. Joseph chapter and from Grand Rapids, Muskegon and Kalamazoo paid a bargain-basement $2.98 to attend the membership award dinner. They were invited by a sign on a narrow-necked jar full of pennies to "Get your two cents change here."

J. R. Barefoot, president of the Federal Machine & Welder Co. of Warren, Ohio, spoke on "Engineering Costs—Who Pays?"

Kalamazoo Chairman Grant Beilfuss proposed that the ten active senior chapters in the state band themselves into a Michigan Council.

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Professor Talks of Space Flights At Indianapolis Education Night

INDIANAPOLIS—Some 125 members heard Dr. C. F. Warner, professor of mechanical engineering at Purdue University, emphasize the close relationship that exists between tool and manufacturing engineers and space scientists at the April meeting. The members also witnessed the presentation of *Tool Engineers Handbooks* to three students from local schools who have maintained the highest scholastic averages in their classes. The winners were Ross Gressly of Purdue, Leon Wagoner of Lain Tech, and Harris Earhart of Acme Tech.

"Jet Propulsion for Space Flight" was the theme of Warner's talk. He began with a comparison of distances. Before the invention of the balloon man could pole-vault to an altitude of about 14 feet. Today he is contemplating a trip to Mars which will require 1000 days of travel at an unbelievable rate of speed.

Next Warner talked of the search for and development of adequate propulsion systems. Whereas chemical fuels once served the purpose, it now appears they will be limited to the primary stages of space exploration. Warner also noted the changes that are occurring with respect to single and multiple engines, length and diameter of housings, staging and timing, and formulas and equations. This is where the tool and manufacturing engineer comes in, the speaker said. The findings of the space scientists must be transformed and translated into something physical. Indeed, he continued, the problems confronting the engineer are far more difficult than those of the scientist. Warner cited societies such as ASTME for making valuable contributions to the field of space technology.

Finally, Warner warned that science and technology are not respecters of nationality and that space conquest is important primarily for purposes of surveillance; communication and weather control are secondary considerations. Flights into space also present problems of psychological and political natures too, the speaker told the members of Chapter 37. Certainly the solutions to these problems are not wholly the task of tool and manufacturing engineers. They must be dealt with by that enormous team which includes not only engineers, but scientists, government leaders and laymen alike.

—James J. Denney

Uses of Numerical Control Heard by Chapter 107

KNOXVILLE-OAKRIDGE—Are your large milling machines removing chips 80 percent of the time? According to Harry Heeb, chief sales engineer at

Giddings & Lewis Machine Tool Co., an aircraft company in Texas has been having this experience using numerically controlled skin mills. Heeb spoke at the April meeting.

In order to accomplish this, the numerically controlled machine tool should be used in the plant for production fabrication rather than as an adjunct to the production line, such as a template fabricating machine, the speaker said.

Heeb also pointed out that the removal of the human element from the machine tool by use of numerical control has emphasized some of the true values of the machinist. In order to replace him, the speaker said, machine design has had to be improved in the field of machine rigidity. Antifriction features have also become a must. It must be recognized that the programming and maintenance of numerically controlled machine tools require technically trained personnel, Heeb added. However, it is possible to increase the output of a machine enough to more than pay for the increased cost. *—R. D. Ellingson*

TOLEDO—A highlight of Chapter 9's March meeting was the presentation of an Award of Merit to A. M. Schmit. Shown handing the award over to Schmit is Francis J. Sehn, ASTME national secretary. *—Robert E. Gregory*

Indian Economy Discussed By Trade Mission Adviser

CINCINNATI—Herbert C. Murrer, president of Murrer Tool Co., Inc., was the guest speaker at Chapter 21's April meeting. Murrer, who has been associated with the tool and die business for 40 years, chose "India, the Keystone for Economic Stability in the Orient" for his subject.

During nine weeks Murrer covered 9000 miles of the four eastern states of India, as a member of a U. S. trade mission to that country. He represented the American tool and die and machine tool industry. The purpose of this mission, the speaker told his audience, was to offer technical information and practical aid to Indian industry. Through the use of mass production methods, it is hoped the standard of living in India will be improved, Murrer concluded. *—Clarence Keller*

Airless Spray Painting Described at Oklahoma City

OKLAHOMA CITY—According to Jerry Little, engineer at Binks Mfg. Co., the average spray painter wastes as much as 50 percent of his paint in overspraying and paint atomization using air-powered equipment. However, a new type of equipment, de-

WICHITA—The new officers elected at a recent meeting of Chapter 52 are (left to right) David H. Duffy, chairman; Orville B. Strahm, first vice; William W. Nibarger, second vice; Frank K. Dickerson, third vice; A. L. Cummins, treasurer; and Glenn A. Stearman, secretary. *—Frank Dickerson*

scribed by Little at Chapter 125's April meeting, operates on hydraulic pressure from 900 to 1800 psi.

This technique not only reduces paint loss, but the amount of time usually spent cleaning up is also cut down. Less solvent is required in paint mixture and a suction fan or spray booth is not necessary. The initial cost is less than that of conventional equipment, Little said.

Little also described a new gun which mixes plastic resin and catalysts just before application. By means of a revolving roller bearing, resin mixtures, some including glass fibers and with pot lives as low as 30 seconds, can be applied with the gun.

—Lee Roy Chapman

Fifteenth Anniversary Celebrated At Cedar Rapids

CEDAR RAPIDS—To help celebrate its fifteenth year with the Society, Chapter 71 invited National President H. Dale Long, charter members and past chairmen to its May meeting.

As the keynote speaker Long addressed the group on the tool and manufacturing engineer's responsibility in meeting the competitive challenge. He pointed out that continued increases in the cost of material and labor and more competition from domestic and foreign manufacturers are proving to be serious problems.

International competition is increasing with leaps and bounds, Long said. Foreign manufacturers are turning out products in their plants, shipping them to this country, paying duty, and still selling the goods cheaper than we can. A good number of these products will lose the public's acceptance when it is realized that the best value is not only in price, but in quality too. However, some of these items are superior to those we turn out. To remedy this the United States is spending $12 billion yearly for research and development in manufacturing technology. In his summary Long said that it is up to societies such as ASTME to keep America on its toes in the manufacturing race being run here and abroad. *—Roy Sadler*

GREATER LANCASTER—This young lady set up one of the many displays at the high school Science Fair held in Lancaster, Pa. recently. Chapter 89 members were invited to attend the fair and view the displays, especially those setup by the local JET chapter.

—Richard J. Kintzi

PITTSBURGH—Outgoing chairman, Raymond J. Zale, presents Walter F. Coles with the chairman's pin for 1960-61 at the March meeting. Both men worked hard to make that chapter's part in the Pittsburgh Bicentennial celebration a success.

—Ralph M. Keenan

Chapter 116 Hears Hydrospinning Expert

KALAMAZOO—Howard R. Limbacher, project engineer at the Ingersoll Kalamazoo Div. of Borg-Warner Corp., was the guest speaker at the April meeting. His subject was hydrospinning, a forming process in which a workpiece is forced to take the shape of a hardened, rotating mandrel.

The workpiece, Limbacher said, revolves with the mandrel and the desired shape is spirally generated by one or two hardened and polished rollers which squeeze and stretch the workpiece around the mandrel as the rollers traverse the mandrel's length. Spinning is an ancient process, Limbacher told the members. One of its first uses was by the Egyptians in the forming of pottery. *—Don Massey*

Chapter 146 Tours Electronics Labs

NORTH SHORE—Bomac Laboratories hosted a tour of their microwave and power tube divisions for the North Shore membership recently. On view at Bomac were those sections which design and manufacture over 900 components used in radar systems for commercial and defense applications.

Preceding the tour was Chapter 146's regular meeting which featured the installation of new officers. This was followed with a briefing on Bomac and its products by Gene Pelligrini, director of personnel, and a discussion of the basic principles of radar and the application of Bomac tubes by Thomas G. Prescott, the company's manager of quality control. —*R. H. Bowen*

Army Space Scientist Speaks At Industry and Education Night

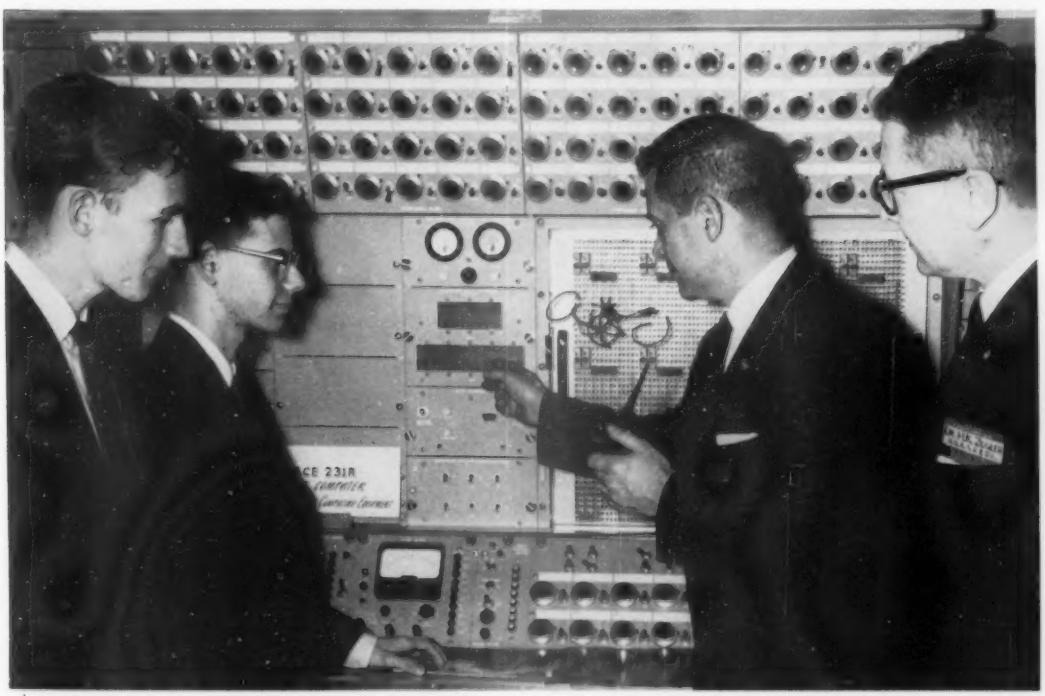
MONMOUTH—"Monmouth County and the Electronic Age" was the keynote of Chapter 130's recent industry and education night. The principal speaker for the evening was Dr. Hans K. Ziegler, chief scientist of the Army Signal Research and Development Laboratories, Fort Monmouth, N. J. He spoke on "Space Electronics."

The chapter was host to 85 outstanding engineering and science students and 35 principals and teachers from the 15 Monmouth County high schools. They heard Dr. Edward Schlaefer, president of Monmouth College, discuss "The Partnership of Industry and Education" in America today.

Stating the viewpoint of industry at this meeting was Karl Wihtol, president of Wihtol Industries and a senior member of the Monmouth chapter. He indicated that this country is suffering from an acute lack of qualified technical people, thus resulting in the notable lag in our space development program. Wihtol stated that "if every man, woman and child in the United States gave his country 10 percent more and asked for 10 percent less, we could solve the dangerous problem of space competition."

Ziegler attributed the urgency in space research to world opinion which thinks of space as "a showcase for a country's capabilities on earth." By doing something in space, Ziegler said, you demonstrate what can be done on earth. He cited the direct relationship of space research to our defense plans and noted that in the competition for world prestige East and West are judged by their accomplishments in space. Ziegler said that today's space exploration may be the first step in providing man with an "out"—presumably to other inhabitable worlds, should it become necessary to leave the earth in the distant future.

To round out the evening's program the chapter had on display a roomful of electronic products including working analog computers, working models of the TIROS and Vanguard satellites, a recording microphotometer, electronic alarm systems, and a number of other electronic devices designed, developed and manufactured in the Monmouth County area. —*Russell Pucker*



Inspecting an analog computer are several of those who were in attendance at the Monmouth industry and education night. From the left they are Stefan Vogt and William Saslaw, students; Harry A. Williamson, Monmouth chapter chairman; and Dr. Hans K. Ziegler, the evening's keynote speaker.

Aluminum Tubing Plant Scene of Catskill Tour

CATSKILL REGION—Chapter 151's April meeting took them to the aluminum tube mill and assembly plant of the Channel Master Corp. Some 60 members were on hand for the event which included installation of the new officers by National Director Joseph L. Petz.

Hosts for the tour were Maurice Roberts, plant superintendent, and Irwin Gutkin, safety manager. They pointed out that, although the firm is primarily known for its production of television antennas, the bulk of its business is devoted to the production of aluminum tubing for the furniture industry. In fact, said Gutkin, Channel Master provides 65 percent of all the aluminum tubing in the United States. Gutkin stated that his company's process is unique in that the tubing is completely fabricated at the Ellenville plant. This includes the casting of their own billets.

Following the tour Roberts traced the history of the Channel Master Corp., saying that it began with two men assembling antennas in a cow barn 11 years ago. *—John W. Mulholland*

Detroit Group Stages Dual Education-Automation Program

DETROIT—A May meeting devoted to two subjects, education and automation, attracted approximately 110 members of ASTME Chapter 1.

The personnel director of the service section at General Motors Corp., Conley O. Bacon, was the first speaker. He was introduced by the chairman of the education program, Arnold Blythe. Bacon's topic was "Shattering the Axioms." In the audience for this meeting were representatives of a number of Detroit area colleges and high schools. Time was taken during this first half of the meeting to present Fred Hill, an engineering student at Wayne State University, with a scholarship award.

Automation program chairman, Bert Bacon, then introduced the second speaker. Nicholas P. Sikich, applications engineer at Kearney & Trecker of Milwaukee, discussed the research and development period leading up to the successful building and operation of his company's Milwaukee Matic automatic milling machine. *—Lloyd S. Hawley*

Two Speakers Featured At Denver's May Meeting

DENVER—James Meehan of Brown & Sharpe, a member of Little Rhody chapter and a frequent visitor at ASTME functions throughout the country, made one of his last stops before retirement at Chapter 77's May gathering. His brief talk emphasized the need for teamwork in American business today. He stated that if both employer and employee would put in a full day's work and stop worrying about trivialities such as coffee breaks and to whom the credit is due, the United States would be in less danger of losing world leadership.

The second speaker on the meeting's agenda was R. F. Schaffer, chief metallurgist at Gardner-Denver Co. Schaffer traced the history of forging from the earliest techniques described in the Bible to modern-day processes such as hydroforming and explosive forming.

—Alan T. Montgomery

EVANSVILLE—Guest speaker George Karian (center) of Iron Powder Sales shows a powdered metal compressor housing to Chapter 73's Walter Lockmueller (left), first vice chairman; and John Schaus, chairman. Karian spoke on "Powder Metallurgy Application and Tooling" at the April meeting.
—Earl R. Crowe

ROCKFORD—At a recent meeting National Vice President William Moreland (left) discussed the improved standard of living that awaits Americans through technological advances. He talked further on the subject with Chapter 12's immediate past chairman, Ernest Norrman, and Chairman H. Walter Lewis. ***—Ray O. Brown***

HENDRICK HUDSON—Looking over the program for the March meeting with the guest speaker, National Vice President Dave Schrom (center), are (left to right) D. E. Dutt and Robert W. Sullivan, chairman and past chairman of the Schenectady chapter; and Gerry Hamme and Gennaro DeRubertis, past chairman and chairman of Chapter 114. The title of Schrom's talk at this joint meeting of the Hendrick Hudson and Schenectady chapters, was "Tomorrow Is Today." Attendance at the meeting reached 200. Representatives from some 89 industries in the area were invited to attend. *—Raymond A. Brooks*

GRAND RAPIDS—Edwin A. Stouten, outgoing chairman of Chapter 38 receives the appropriate pin from John Pridgeon, vice chairman of the National Membership Committee. Ivan G. Haan (left) was installed as new chairman at this March meeting.
—Ray Kutschinski

SANTA CLARA VALLEY—Some 75 members of Chapter 98 were on hand to hear Jacob J. Jaeger discuss numerically controlled machine tools at the April meeting. Jaeger, who is president of Pratt & Whitney Co., is seen here with Chairman John Groves.
—Carl A. Strombom

OAKLAND COUNTY—Austin D. Esler (left), chief process engineer at General Motors Truck and Coach Div., installed the 1960-61 officers at the March meeting. They are (left to right) Charles T. Gaffney, chairman; Albert Post, second vice chairman; Charles Blessed, secretary; and Robert Grant, treasurer. Walter Morris, not shown in the photo, is the new first vice chairman. *—Edward Teal*

Reports in Brief . . .

New England

Two Chapter 32 members, one who placed third in THE TOOL ENGINEER gadget contest and another who received an honorable mention, were honored at the April meeting of the SPRINGFIELD, Mass., chapter. They were Allen Johnson and Bob Dickson, both past chairmen of Chapter 32. Robert E. McKee, sales manager of R. K. LeBlond Machine Tool Co., was the guest speaker for the evening. . . . WORCESTER chapter members heard J. Murray Stevens, research director of Lowell Industries, Inc., discuss vibration damping for machines and accessories at their April gathering.

Southwest

ASTME National Vice President Philip R. Marsilius appeared as guest speaker at NORTH TEXAS chapter. Marsilius, who is executive vice president and sales manager of the Producto Machine Co., discussed the "Manufacture and Uses of Punch Press Die Sets." He was introduced to the audience by National Director Irving H. Buck.

Mid-Atlantic

Problems arising in the construction of high-speed aircraft were discussed by John S. Thorpe of the research and development laboratories, Allegheny Ludlum Steel Corp., at a meeting of the ITHACA chapter. Thorpe said stainless steel and other alloys are now being employed because they are not only light, but strong. Other metals are also being tested to determine whether they can withstand drastic temperature changes. . . . Using his own company as an example, Alfred R. Sparrow, director of grinding machine sales at Brown & Sharpe Mfg. Co., explained how industry today is measuring and controlling a millionth of an inch. At PATERSON'S May gathering Sparrow said his company can produce such close dimensions on parts because of a unit they have developed which is attached to a grinding machine and which operates on the principle of elastic deformation.

Midwest

Nicholas P. Sikich, sales department applications engineer at Kearney & Trecker Co., introduced 85 MILWAUKEE chapter members to the operation of a numerically controlled milling machine at the April meeting. He noted that numerical control was originally put to the test in the aircraft industry, but that lately it is finding increasing acceptance in other fields, particularly in small-lot production. . . . Outer space prompted the first use of optics as a tool and so it remains today. According to R. C. Schneider, optics engineer at Engis Equipment Co., who spoke at the SPRINGFIELD, Ohio, chapter meeting, Galileo began it all when he peered through a lens in a tube to study the planets. Today's missile experts depend on optical tooling to check component parts, missile guidance systems, ground supports and launching apparatus. . . . Some 110 members of the SOUTHERN MINNESOTA chapter followed Dr. E. J. Baldes of the biophysics department at the Mayo Clinic on a tour which included inspection of a human centrifuge machine. Baldes discussed the machine's use in connection with space travel and the astronaut program. . . . At the May meeting some 74 members of the

DAYTON chapter heard Dave Schrom, ASTME national vice president and works manager of the York Div., Borg-Warner Corp., express his views on the question, "Are Tool Engineers Really Square?" Schrom's talk dealt with the materialistic attitude being adopted by some tool and manufacturing engineers in both their jobs and everyday associations. . . . Some 73 members of LANSING heard Erwin G. Loewen, technical director of the Taft Peirce Mfg. Co., Woonsocket, R. I., review the possibilities of electronic gaging in the field of automation at the May meeting. Loewen supplemented his talk with a series of color slides.

A past chairman of the MILWAUKEE Chapter 4, Joseph Ebner, died recently. Ebner, who was 50 years old, had been an active ASTME member since 1941. Another MILWAUKEE member, Charles S. Jorgenson, died in April. He was chief engineer at the Milwaukee Press & Machine Co. Paul B. Cox, who had been in the INDIANAPOLIS chapter since 1944, died recently. He had been working as a service engineer for Winter Bros. in Indiana.

West Coast

At a joint meeting of the GOLDEN GATE and SAN FRANCISCO chapters, Jacob J. Jaeger, president of Pratt & Whitney Co., Inc., expounded on numerical control as applied to machine tools. The members, who numbered about 150, heard Jaeger emphasize the low cost of numerical control when utilized on production lots as small as four items. . . . The April meeting of the LOS ANGELES chapter was devoted to a presentation entitled "Tooling for the DC-8." Edward W. Hendry, tool engineer at Douglas' Long Beach division, narrated a film depicting the birth of the jetliner. His discussion included an explanation of many tooling applications involved in the development of the DC-8. . . . A talk based on the actual tests conducted by the Aerojet-General Corp. on space-age metals was offered by A. M. Derrico at the SAN FRANCISCO chapter's May gathering. Derrico, a cutting tool engineer, discussed the performances under trial of metals such as pure tungsten, titanium, molybdenum and astrolite. . . . "Electrolytic Machining" was the topic up for discussion at the SANTA CLARA VALLEY chapter's May meeting. An audience of 55 members and guests heard H. A. Whitefield, sales engineer for Anocut Engineering Co., and George Merryweather of Merryweather-Strasmann Machinery Corp., put forth their views on this subject.

Matthew M. Margulies of Burbank, Calif., a member of the LOS ANGELES chapter for the past ten years, has died. He was a director at the California Institute of Tool Engineering.

.....special events.....

Long-Range Planning Committee Meeting	Aug. 6-7, '60	Dearborn Inn Dearborn, Mich.
ASTME Semiannual Meeting	Nov. 14-18, '60	Ambassador Hotel Los Angeles, Calif.
ASTME Western Tool Show	Nov. 14-18, '60	Memorial Sports Arena Los Angeles, Calif.

positions wanted

MANUFACTURING ENGINEER, B. S. I. E.—Registered mechanical engineer. Ten years' diversified experience on aircraft, missile, automotive, in design, manufacturing, quality control, four years supervisor, familiar with latest manufacturing processes and materials, both high and low-volume production. Work with personnel at all levels. Have drive and follow-through. Work well under pressure. Seek supervisory or responsible staff position. Write to Classified Ads, Dept. 179, 10700 Puritan Ave., Detroit 38, Mich.

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TOOL AND METHODS ENGINEER—with BSME or BSIE degree and 8 to 10 years of tool design experience. Also five years of methods work and a minimum of three years' supervising personnel in tool and methods. (Experience may have run concurrently.) Individual must have an extensive knowledge in the following areas: (a) shortrun production tooling; (b) precision sheet metal parts; (c) small machine parts and castings; (d) wiring harness assemblies of electrical components. Prefer individual who has had practical machine shop experience. Responsibilities will be supervising the tool and methods section of a small Long Island electromechanical concern. Liberal employee benefits include stock purchase plan and tuition reimbursement. Send resume including salary requirements to Box TE776, 125 W. 41 St., New York, N.Y.

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Progress in Production

IMPREGNATION SYSTEM AUTOMATICALLY SEALS CASTING LEAKERS

An improved automatic batch type impregnation system for sealing casting leakers is now being built by Prenco Mfg. Corp., Royal Oak, Mich. Scheduled for delivery to a large auto manufacturer, the system will use a metal oxide type sealant to impregnate cast aluminum engine parts for a new compact car.

The system consists of two 5 by 5-ft capacity autoclaves, a sealant supply

Impregnation system in process of completion. In operation the machine will be placed in pit, bringing lids to operator level.

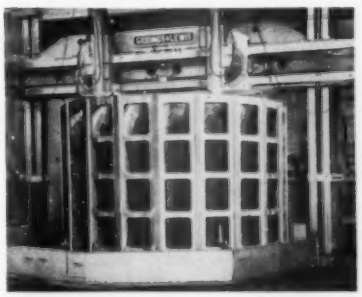
tank, a hot water recovery tank and suitable automatic valving, safety devices and electrical controls. An outstanding new operating feature designed into the system is a hot water rinse which permits washing of the parts in the autoclave following impregnation. This procedure achieves a thoroughness in removal of excess sealant unattainable with conventional wash and rinse methods. Hot water used in the wash phase of the machine cycle is recovered in a special heated tank.

The giant autoclaves are equipped with fully automatic electropneumatic devices for lifting and swinging the lids. Once the parts have been loaded into baskets and lowered into the autoclave, a push of the "start" control button initiates the impregnation and wash cycle. The complete cycle is fully automatic and requires no attention from the operator other than monitoring of the control panel to visually insure proper sequencing of all components.

The sealant supply tank holds enough sealant to serve both tanks. It contains integral heat controls and elements, mixing apparatus and liquid level indicator. The autoclaves may be cycled simultaneously or separately as required.

AUXILIARY TABLE INCREASES BORING MILL CAPACITY

Workpieces in a wide range of sizes are machined efficiently on a new 100-hp vertical boring mill with 20-ft swing. Built by Giddings & Lewis Machine Tool Co. for Verson Allsteel Press Co. the machine is equipped with a 12-ft diam table over which is fitted a 16-ft diam table for machining large workpieces. Because the large table is removeable, the operator can handle



Boring mill in operation. Tables can be alternated to accommodate various sizes of work.

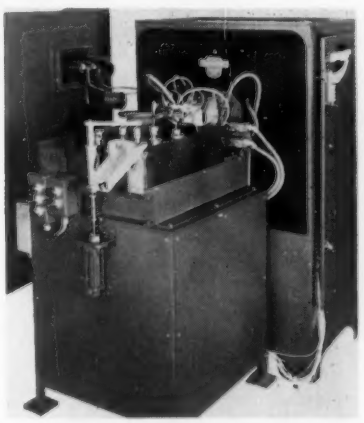
smaller workpieces more easily while achieving more efficient machining speeds than would be practical with the 16-ft table.

Table loads up to 75 tons are made possible by a double antifriction bearing-table track and a double preloaded tapered bearing at the center of the table. The center bearing also takes all radial thrust.

Control of all machine functions is provided in a pendant station. In addition, pushbutton stations are provided at each end of the rail for table start and stop. Verson will use the new mill in the machining of large press assemblies and make it available in their contract machining services.

INDUCTION HEATING UNIT HARDENS TRUNNION BEARINGS

Inside diameters and bottoms of trunnion bearings can now be hardened at the rate of one every 6.8 seconds through the use of a Ther-Monic unit. Designed and built for the Saco Lowell Automotive Div. by the Induction Heating Corp. of Brooklyn, N. Y., the machine utilizes a rotating work station with eight spindles which also rotate during the heat and quench cycle. Operator function is limited to loading parts on the spindles and pressing a start button to initiate the automatic cycle. As the station rotates, each spindle is precision fixed beneath an air-operated coil, which is then automatically lowered into the fixture. The hardening process is accomplished through the entire inside of the bore, including the bottom. Tolerance of 0.0015 inch is maintained throughout the bore.



Induction hardening machine for trunnion bearings. Power supply is 25 kw generator. Fixture has complete operating controls for both generator and work station.

When the heat and quench cycle has been completed, the bearing is transported on the rotating table to an automatic ejection chute.

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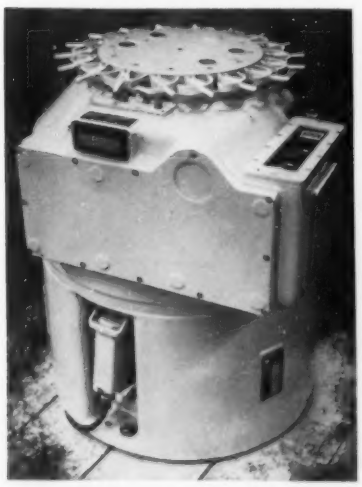
Capable of indexing from any point in 360 deg to any other point with an accuracy of ± 1.5 seconds of arc, this table has digital readout that provides unusual speed, ease and dependability of opertion. Degrees, minutes and seconds are read directly on a dual set of counter type indicators engineered



so that windows never show half-turned numbers as counters go through the transfer stage. Accuracy of positioning is insured by warning lights that operate if correct procedures to remove backlash from the rotating mechanism have not been followed. Although principally designed for use as azimuth indicators in missile aiming systems, the table is suitable for industrial applications where extremely accurate circular spacing or angular positioning is required.

Pratt & Whitney Co., Inc., West Hartford 1, Conn. **Circle 301**

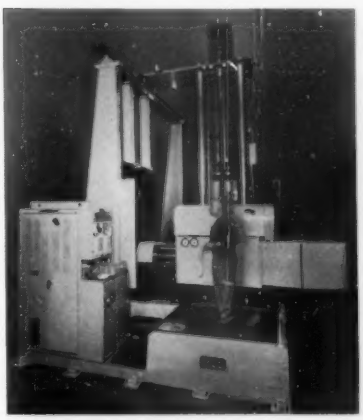
Gear Reducer

More than 70 reduction ratios are possible with a miniature gear reducer. Change gears included with the unit provide reductions of 24:1, 40:1, 60:1, 120:1, 240:1, 360:1 and 600:1. Additional gears available from stock will provide maximum ratios. Maximum rated output torque of the unit is 130 oz-in, operating load torque is 65 oz-in, starting torque is 0.02 oz-in and maximum backlash is 30 min.

Great Eastern Mfg., Inc., P. O. Box 121, Springfield, Vt. **Circle 302**

Numerically Controlled Jig Drilling Machine

Designed for programmed drilling of holes in parts or groups of parts measuring up to 10-ft square, this machine is ideally adapted to the drilling of hole patterns and bolt circles in condenser tube sheets. Such sheets or vessels longer than 10 ft, but within the

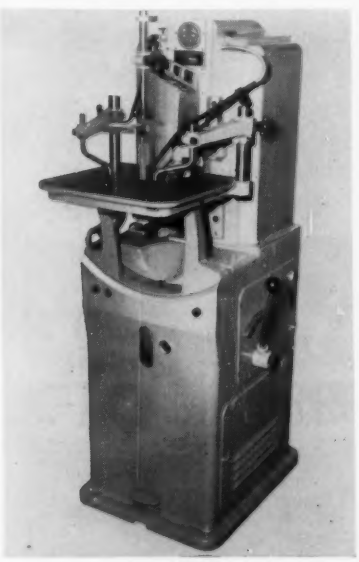


10-ft height dimension, can be handled by indexing the part horizontally and floating in the correct zero setting for tape programming. A part 33 ft long can be programmed on one tape. In the machine, work to be drilled is clamped in a work fixture and held stationary while the drill head is moved vertically and horizontally to programmed positions for drilling. A floating zero arrangement in the numerical control system enables a number of smaller parts to be clamped simultaneously in the work fixture and accurately drilled under tape control. Positioning of the single-spindle drill head can be done manually by decade button or by the punched tape control. Sixteen speeds are available in a range from 50 to 5000 rpm. Feed rates for the spindle are up to 120 ipm. Maximum quill travel is 26 inches.

Water P. Hill, Inc., 22183 Telegraph Rd., Detroit 19, Mich. **Circle 303**

Filing, Sawing Machine

Infinitely variable speed and length of stroke, 9½-inch throat depth, and an 18 x 18-inch worktable that tilts in four planes through 15 deg are features of this model 115 Thiel machine. Work holddowns, magnifying glass, chip blower and lamp are provided with the



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AIR-OPERATED TOGGLE CLAMPS

600-4000 lbs. holding pressure

300 to 900 lbs. clamping pressure

De-Sta-Co air-operated clamps are built to give long, trouble-free service... hardened bushings and pivot rods are standard of the many quality features.

Clamping and unclamping are both actuated by normal air line pressure of 90 lbs.

Whatever the use: Series, sequentially, simultaneously... or individually, De-Sta-Co air-operated Toggle Clamps hold securely—speed production!

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DETROIT STAMPING COMPANY
350 MIDLAND AVENUE
DETROIT 3 MICHIGAN

Use Reader Service Card, CIRCLE 33

unit. Both compression and tension type files can be used on the machine. Rotary or stationary files with sintered diamond chips are used in machining of carbide or hard steels. Straight sawing is done with a round file rotating at 12,000 rpm while reciprocating up and down. Feed can be manual or by means of a sub-table equipped with counter weights.

United Machine Tool Co. of Calif., 3620 Santa Fe Ave., Los Angeles 58, Calif. **Circle 304**

Power Feed Drill Press

Available in 18 models, including bench, floor, multiple-spindle and as an overhead track-mounted tool, a line of 20-inch power drill feed presses have up-front controls that permit one-hand operation. The press has a connection from which automation devices such as rotary tables can be controlled and synchronized with spindle operation. There are four feed ratios—0.004, 0.006, 0.009 and 0.012 ipr—with each of the five spindle speeds. The front mounted pilot wheel control is mechanically integrated with the clutch control. Features include six-inch spindle travel; heavy-duty spindle construction; easily read depth gage; and quick-release, cam-actuated motor mount.

Delta Power Tool Div., Rockwell Mfg. Co., 470 N. Lexington Ave., Pittsburg 8, Pa. **Circle 305**

Ceramic Tooling Material

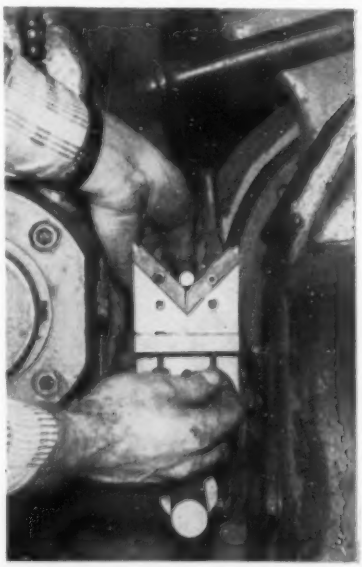
Readily molded using a slip casting technique in plastic molds, S-2 ceramic material can be used in applications that require heat up to 3000 F. The material is first mixed with water and poured into a mold, allowed to set up in air, and baked out at a low temperature to remove moisture. Applications in high-temperature processing include

brazing and welding fixtures, hot forming dies, and sintering and diffusion boats. The material has also been used as an encapsulant for heating coils and resistance heating elements. The application illustrated is aligning an aircraft strainer assembly for copper brazing. In this application, the ceramic casting replaced in inconel brazing fixture.

Duramic Products, Inc., 426 Commercial Ave., Palisades Park, N. J. **Circle 306**

Centerless Grinder Supports

Adjustable V outboard workpiece supports, for use with all makes, types, sizes and models of centerless grinders, give full diametral coverage of the machine. Each unit consists of a front and back support, brackets and soft jaws which prevent scratching of the



workpiece on the output side of the grinder. Bars up to six ft in length can be fully supported by most grinders by adding extra adjustable V-heads and longer cantilever brackets. The supports are usable for through-feed, spot or plunge grinding if all materials, adjust accurately to any size and eliminate taper to the ends of the workpiece.

Livingston Tool & Development Co., P.O. Box 549, Belmont, Calif. **Circle 307**

Heat-Resistant Paint

Steel jigs, fixtures and formed products can be protected during brazing and welding operations with a heat-resistant paint that will withstand temperatures up to 1700 deg. Available in

both aluminum and clear vehicles, the H-170 paint is recommended for fine tolerance work. It can be applied by spray, dipping or brush.

Speco, Inc., 7308 Associate Ave., Cleveland 9, Ohio. **Circle 308**

Workholding Unit

Developed for use in light production, this device can be quickly and easily changed with a screwdriver to accommodate production run changes. It can be put together in any shape and can be bolted to worktable or bench or used with the manufacturer's power

arm. The holder is available in individual components or as a kit that contains two 18-inch perforated strips of ¼-inch aluminum plate, three 90-deg connecting angles of the same material, two toggle clamps and a dozen screws and nuts. Perforations measure ¼ inch

Wilton Tool Mfg. Co., Inc., Schiller Park, Ill. **Circle 309**

Self-Locking Retaining Ring

Two slots and two punched tangs effect the self-locking action in a two-turn, spiral-wound retaining ring. The ring locks when high-speed rotation applies centrifugal force, or when dirt or other foreign material forces the ring out of groove. Manufactured from flat spring steel, the ring is coiled on edge to make a 360-deg retaining surface. It has no lugs or protuding parts and can be installed or removed without special tools. The rings can be coiled to any diameter within the limits of the material used and can be furnished in a variety of materials and finishes.

Ramsey Corp., Box 513, St. Louis 66, Mo. **Circle 310**

Drilling Machine

Model 604 operates from shop air line with three-inch diam air cylinder providing a drill thrust of approximately seven times the line pressure. Hydraulically controlled feed rate is continuously variable. Threaded adjustable sheaves on the motor and spindle drive provide spindle speeds of from 600 to 4000 rpm. The unit has either a single or three-phase motor, air controls, work light and oil groove table with raising mechanism. It is available with a No. 2 Morse taper spindle socket or ½ inch chuck.

The Electro Mechano Co., 241 E. Erie St., Milwaukee, Wis. **Circle 311**

Miniature Grinding Wheels

Abrasive wheels as small as 0.036-inch diam and as thin as 0.016 inch were designed for use in miniature precision bearing manufacture and are additionally usable in jig grinder applications. The wheels maintain size

with infrequent and minimum dressing. Grinding ratios of volume stock removal as high as 100 to 1 have been obtained on 60 R_C hardened bearing wheels.

Norton Co., Worcester 6, Mass. **Circle 312**

USE READER SERVICE CARD ON PAGE 135 TO REQUEST ADDITIONAL TOOLS OF TODAY INFORMATION

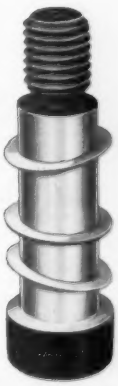
IT'S A FACT

YOU CAN DO BETTER WITH

DE-STA-CO

SHOULDER SCREW LENGTHENING AND SHORTENING SHIMS

DE-STA-CO LENGTHENING SHIMS screw on threads, won't drop off and be lost. Made of spring steel, will not mushroom or break.



DE-STA-CO SHORTENING SHIMS fit snug around shank, lie flat and true on head. Replace costly, inaccurate hand-made washers.

FOR MORE FACTS WRITE FOR DESCRIPTIVE LITERATURE AND PRICES

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360 MIDLAND AVENUE DETROIT 3, MICHIGAN

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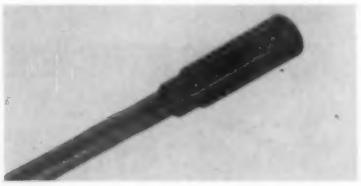
Use Reader Service Card, CIRCLE 34

TOOLS of today

Proximity Pickup

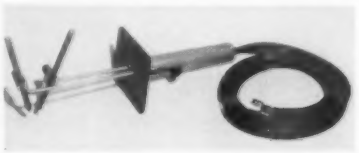
Designed for use while submerged or on machines using cutting oil or coolants, this small sensing unit for proximity control systems detects both ferrous and nonferrous metal parts having a diam of less than 1/10 inch. The unit can be excited by gear teeth of 10 diametral pitch. Mounted at the point of work, the pickup has a 10-ft cable potted in place and connecting to a proximity control unit. It can detect both stationary metal objects and moving metal pieces passing it at a rate of 60,000 per minute.



Electro Products Laboratories, Inc., 4500 N. Ravenswood Ave., Chicago 40, Ill. **Circle 313**

Welding Torch

Two cored carbon electrodes, easily maintained at proper distance, produce the arc in this torch that can be used with any a-c welding machine. The unit produces satisfactory welds as well as production brazing, soldering and heating.



Aircair Co., P.O. Box 431, Lancaster, Ohio. **Circle 314**

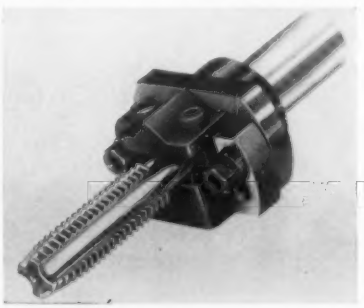
Replaceable-Blade Counterbores

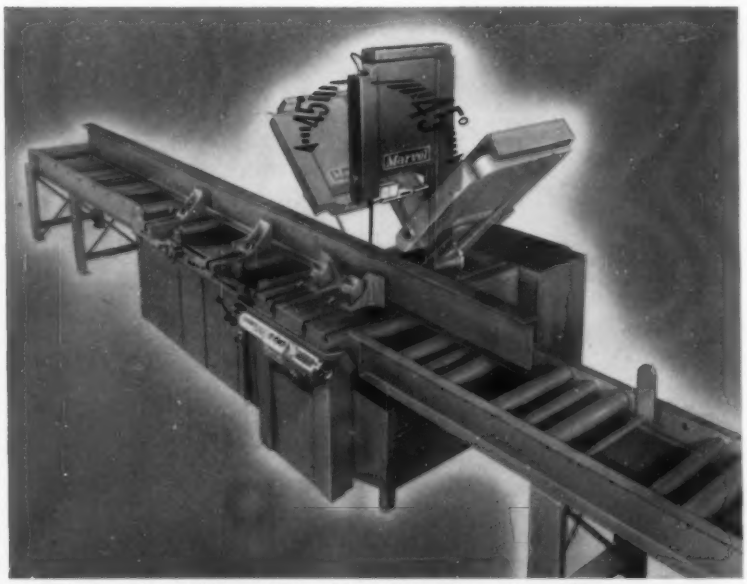
High-speed steel blades can be economically replaced as well as interchanged so that blades of the same thickness can be used with different shanks and pilots of the set. Included are five shafts which serve as both shank and pilot, ten blades and two extra pilots. Screw sizes covered in the set are No. 10, 1/4, 5/16, 3/8, 1/2, 5/8 and 3/4 inch. Pilots and blades are 1/32 inch oversize to allow for clearance. The 24 blade sizes are standard. The counterbores, also usable for spot facing, are available singly as well as in the set.

The DoAll Co., Des Plaines, Ill. **Circle 315**

Nonreleasing Tap Holder

Bushings are eliminated and tool inventory reduced when this V-jaw tap holder is used in screw machine setups.





Tips Its Head To Cut Production Corners

Sawing 45° miters in any kind of material has always been a simple task for MARVEL Saws, but moving the work up automatically and making consecutive cuts on an angle was a problem, especially when the work was long and cumbersome.

This triple exposure photograph of a new MARVEL No. 81A All Hydraulic Heavy Duty Automatic Bar Feed Band Saw, illustrates how the upright head or column can be tipped 45° either right or left of vertical to make angle or miter cuts. The work is held stationary while the column, which carries the blade, is fed forward, meeting the work squarely to insure accurate cutting. After the cut is completed, the work is automatically moved up and measured, and another cut made.

Automatic miter cutting is just one of many exclusive universal features of these band saws. Designed to utilize every advantage of high speed steel band blades, MARVEL No. 81 Series Band Saws can handle almost any conceivable sawing job—from the smallest, most delicate work, up to 18" x 20" shapes.

Only the MARVEL No. 81 Band Saws have the "SURE-LINE" Automatic Accuracy Control (basic patent applied for) which literally steers a blade to make a straight cut. This unit extends usable blade life as much as 50%.

MARVEL No. 81 Series Band Saws are proving themselves daily, as the most versatile machine tools in production metalworking plants.

For complete details, or a demonstration of MARVEL Sawing Equipment, write: Armstrong-Blum Manufacturing Co., 5700 W. Bloomingdale Ave., Chicago 39, Ill.

MMT-PE

MARVEL Metal Cutting SAWS

Use Reader Service Card, CIRCLE 35

The slip-in unit accommodates either extended or close-held taps and provides automatic, axially accurate tool alignment. It eliminates the cutting off of tap shanks and will not loosen, twist, creep or shift. A wide range of tap sizes can be used with the holder.

Brookfield, Inc., Stoughton, Mass. **Circle 316**

Lathe Collet Chuck

Model 50 collet chuck has a handwheel-operated, nose type closure and "Rubber-Flex" collets. The unit provides rapid collet change, capacity increases up to 42 percent, runout of no more than 0.001 inch at the nose, and bar capacity of from 0.100 to 1.063 inches. The chuck also furnishes maximum gripping power for heavy duty cutting on light lathes and direct spindle mounting without use of a thread adapter. The Model 50 can be used to chuck tubing and fragile materials, and will hold round pieces on drill press tables, milling machine tables and magnetic chucks.

The Jacobs Mfg. Co., West Hartford, Conn. **Circle 317**

USE READER SERVICE CARD ON PAGE 135 TO REQUEST ADDITIONAL TOOLS OF TODAY INFORMATION

Two-Way Valve

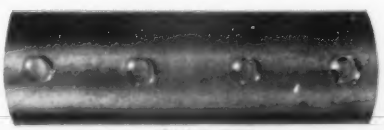
Roller-operated, this two-way valve has a hardened and ground poppet and seat assembly that are lapped together to prevent internal leakage in the closed

position. The poppet is also hydraulically balanced in the open or closed position, keeping constant the force required to operate the valve regardless of the position of the poppet. Standard

ALLEN

Allenpoint's deep, full-circle bite assures tremendous resistance to removal torque! Stays tighter longer!

When you need a set screw that you can depend on to stay tight under heavy strain and vibrations, specify ALLENPOINT. Here's why you can always depend on ALLENPOINT: proper design of the cup diameter results in a rugged grip that makes the full-circle pattern you see here... deep, strong, clean sockets allow full wrenching leverage... and uniform Class 3A threads assure a tight friction lock over the entire length of Allenpoint Set Screws.



Ask your ALLEN Distributor for samples and full engineering details—he's always ready, willing, and able to give you prompt, practical service!

50 ANNIVERSARY YEAR ALLEN HEAD 1910-1960

ALLEN MANUFACTURING COMPANY

HARTFORD 1, CONNECTICUT, U.S.A.

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For smoother, easier drawing and forming

ask Oakite

OVER 50 YEARS CLEANING EXPERIENCE • OVER 250 SERVICE MEN • OVER 160 MATERIALS

Oakite DRAW CLEAN "M" cuts forming rejects, lengthens tool and die life, washes off fast

New Oakite Draw Clean "M" lubricant smoothes the way for lower reject rates on drawing and forming steel, aluminum, copper and brass. How? Draw Clean "M" clings to metal with such tenacity that pressures of 40 thousand psi cannot wipe it off. Even the thinnest film will prevent seizure that causes build-up, galling and scratching.

The components of Draw Clean "M" are soluble and, at annealing temperatures volatile. This is important to you because while it clings where most other compounds wipe away—it can be removed easily in a mild detergent solution. Yet the residue, if allowed to remain, is not harmful to metal or man.

By diluting with water in ratios as high as 1 to 9 Oakite Draw Clean "M" offers astonishing per-unit cost savings. It extends die life three times the previous experience. Miscible with both water and oil it may be adapted to any of the following:

light stamping	stretch forming	spinning
deep drawing	tube bending	punching
cold heading	tapping	wet grinding

Ask your Oakite man for bulletin F-10393 or write Oakite Products, Inc., 26H Rector Street, New York 6, N. Y.

it PAYS to ask Oakite

OAKITE SCIENCE

over 50 Est. 1909 years' leadership in industrial cleaning

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packings are suitable for hydraulic oil, and packings for use with other fluids can be supplied. Maximum allowable pressure is 1500 psi at the in port of the valve and 500 psi at the out port. Rated flow is 30 gpm and a force of 45 lb is required to operate the plunger. The roller can be supplied 90 deg from the position illustrated.

Barworth, Inc., 681 Morris Turnpike, Springfield, N. J. **Circle 318**

Portable Press

Pressure range of this portable press is 50 to 1500 lb. Primarily an arbor press designed for small work and fabricating jobs, the unit has a 4-inch stroke, 1-inch ram and 5⅛-inch throat.

The hydraulic power unit and ¾-hp motor are operable with 100-volt, 60-cycle current. Automatic controls will synchronize with any machine tool or production line. It is also available with hand lever, pushbutton or foot controls for low production use.

John S. Barnes Corp., 315 S. Madison St., Rockford, Ill. **Circle 319**

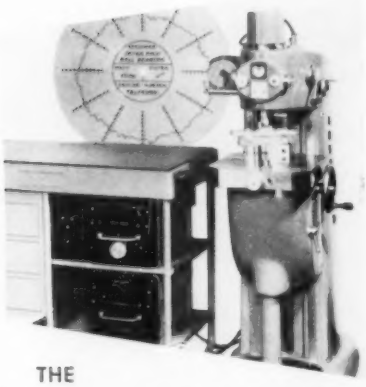
Masking Solution

Protection for nonmilled surfaces of stainless steel can be provided by a masking solution that resists etchant attack for 8 hours at 140 F and can be either dipped or sprayed to form a tough, pliable, rubber-like film thickness of 10 to 12 mils. After chemical etching of the desired area is completed, the masking-protected area can be stripped clean of its protective coating by peeling it off in large strips.

Rinched-Mason Co., 5935 Milford, Detroit 10, Mich. **Circle 320**

ROUNDNESS
CONCENTRICITY
COAXIALITY
TO .000001"

recorded on inkless polar chart—with...



THE
TALYROND

This electronic master instrument measures and records roundness, concentricity, coaxiality and squareness on all units of circular cross section up to 12" ID or OD; height 10". As test piece remains in fixed position, the rotating spindle is unaffected by size, balance or shape of work—the spindle is guaranteed to .000001"* and magnifications to 20,000X* are recorded on the polar graph.

*Optional

...New

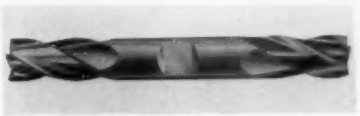
Special stylus types, increased vertical capacity, table for centering and squaring up.

ENGIS
EQUIPMENT COMPANY
DIVISION OF ENGINEERING AND SCIENTIFIC INSTRUMENTATION
431 SOUTH DEARBORN STREET
CHICAGO 5, ILL.

Use Reader Service Card, CIRCLE 38

Double-End Mills

Two and four-flute, double-end mills, ground from high-speed steel, are usable in a number of end milling operations. Both the two and four-flute



mills (illustrated) are available in sizes of 1/8, 5/16, 1/4, 5/16, 3/8, and 1/2 inch.

Brown & Sharpe Mfg. Co., Providence 1, R. I. **Circle 321**

Self-Sealing Coupling

Fast, safe connections in applications where positive locking is essential can be assured by 3750 coupling developed for use in aircraft fuel, oil, low-pressure hydraulic, pneumatic and similar systems. Check points used to verify positive connection are an audible click action and indicator pins that protrude

externally when coupling is locked, allowing both visual and manual determination of the indicator pin position. Positive thread action of the nut permits connection against line pressures up to 60 psi. Couplings are available in a variety of end fitting configurations.

Aeroquip Corp., Jackson, Mich. **Circle 322**

USE READER SERVICE CARD ON PAGE 135 TO REQUEST ADDITIONAL TOOLS OF TODAY INFORMATION

Expanding Transfer Punches

Through an expanding feature, a set of three transfer punches have a size diameter range from 1/4 to 11/16 inches, or 437 thousandths. True centering of the punches provides accuracy to 0.001 inch. The expansion feature eliminates sticking of punches in drilled holes and, in overhead or horizontal work, the punches can be expanded to hold and will not fall out or tip.

Kelly Tool & Mfg. Co., 3408 Monterey Rd., Los Angeles 32, Calif. **Circle 323**

ONLY

CAPEWELL

is the originator and developer of the revolutionary new L-100-M

SPEED-BAND®

double carbide Band Saws

ONLY

available from authorized CAPEWELL Distributors

Ask your Capewell Distributor for the complete story

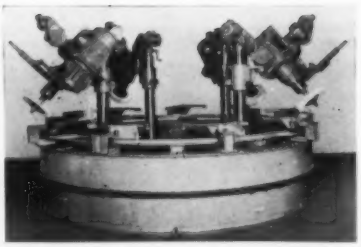
CAPEWELL

THE CAPEWELL MFG. CO.
HARTFORD 2, CONN.

Use Reader Service Card, CIRCLE 39

Automatic Buffer, Polisher

Parts with sweep or angular shapes are adapted to finishing on this rotary conveyor automatic polishing and buffing machine. Twelve feet in diameter, the machine consists of a rotating outer conveyor ring and a stationary inner ring. Workpieces are mounted on fixtures on top of an eight-inch wide table on the rotating ring, and move past buffing wheels mounted on adjustable

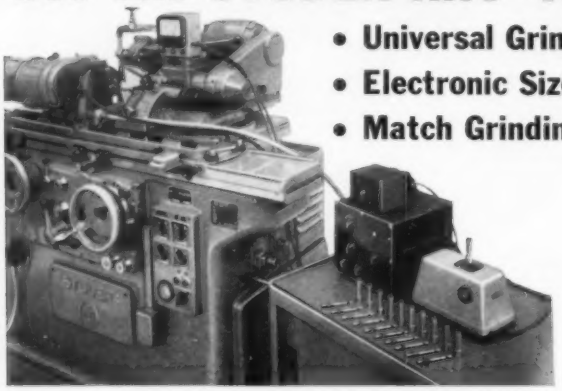


lathes spaced around the inside of the conveyor. Cam rails mounted on the stationary inner ring can operate in conjunction with pivoted fixtures to move the part to controlled positions at various stations around the periphery of the machine. The number of work fixtures mounted on the table varies with part shape, length and finish requirements. Up to six adjustable lathes can be placed inside the rotary conveyor and an equal number can be mounted around the outside if required. The conveyor travels at speeds of from 8 to 32 fpm and finishes angular-shaped automotive trim at a rate of 350 pieces per hour.

Acme Mfg. Co., 1400 E. Nine Mile Rd., Detroit 20, Mich. **Circle 324**

Use The STUDER RHU-450 For

- Universal Grinding
- Electronic Size Control
- Match Grinding



Studer RHU-450 Universal Grinder with electronic equipment.

Special electronic measuring controls on the new Studer RHU-450 Universal Precision Grinder permit extremely fine accuracy and a more versatile range of grinding operations for match grinding, internal and external grinding, superfine and lap grinding.

MOVOLIMIT Electronic Size Control, for highly accurate grinding to pre-determined diameter from a master part or the first workpiece in the run. The grinding operation is controlled automatically, independent of grinding wheel wear.

DELTALIMIT Match Grinding Instrument, for match grinding a shaft to fit a specific bore diameter. DELTALIMIT equipment is ideal for grinding servo valves, plungers and barrels, and other mating parts requiring tolerances in the millionths.

Other Features—handles workpieces up to 18″ between centers with 8″ swing—workspindle speed infinitely variable from 30 to 650 rpm—cylindrical cam grinding attachment—taper grinding attachment.

Electronically mated parts produced on a Studer RHU-450.

Write For More Information

COSA *Importers of Leading Precision Machine Tools*
Nationwide Sales and Service
COSA CORPORATION, 405 LEXINGTON AVENUE, NEW YORK 17, N.Y.
In CANADA contact COSA CORPORATION OF CANADA, LTD., 1160 Lakeshore Road, Long Branch, Toronto 14, Ont.

Use Reader Service Card, CIRCLE 40

Double-Disk Grinder

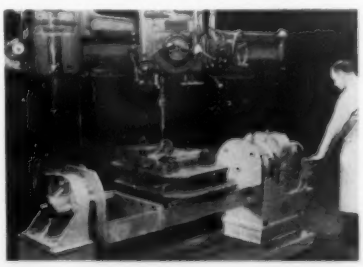
Chain saw guides in variable lengths to 60 inches are fed into this double-disk grinder without adjusting the load and feed mechanism. Closely spaced drive links drop into neutral position when interference pressure from the piecepart is applied. The next free link

drives the part, permitting a variety of different sized parts to be fed in the same production run. On high-carbon steel guides, total stock removal of 0.015 inch is accomplished in a single pass at a feed rate of 8 fpm, equaling 5 cu inches of stock removal per minute. Size is held to 0.002 inch and parallelism, end to end or side to side, is held to 0.001 inch.

Mattison Machine Works, Rockford, Ill. **Circle 325**

Indexing Positioner

Index stations of this powered positioner provide 24 positive positions with a range of 0 to 360 deg. Drilling, reaming, tapping and counterboring can be done with the unit. Index tolerance, measured on the OD of the

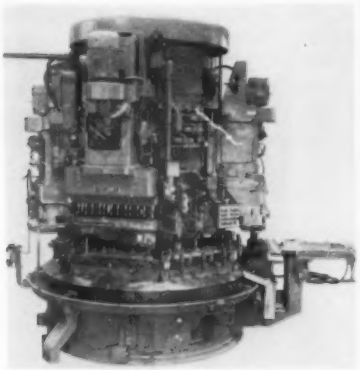


plate, is 0.0025-inch max. Load capacity is 2000 lb, range of the vernier plate is 0 to 15 deg, swing over the sub base is 36 inches, cradle width is 25 inches and cradle gap between index head and outboard support is 48 inches.

Production Tool Div., Johnson & Bassett, Inc., Worcester, Mass. **Circle 326**

Vertical Drilling Machine

Eight hundred steel forgings an hour at 100 percent efficiency can be both drilled and milled with this unit. It can produce 400 automotive type connecting rods and 400 rod caps per hour. Operator-loaded, the machine is



otherwise automatic. Hydraulically operated work fixtures rotate around the center column on which the drill heads are mounted. Drilling rate of the Model 57 spindle machine is 3 ipm and reaming rate is 5 ipm.

The Foote-Burt Co., Cleveland 8, Ohio. **Circle 327**

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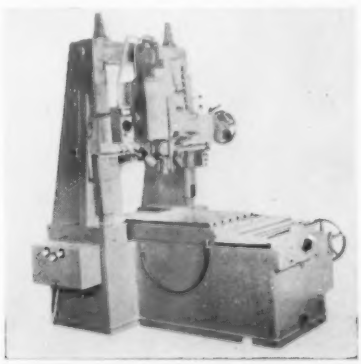
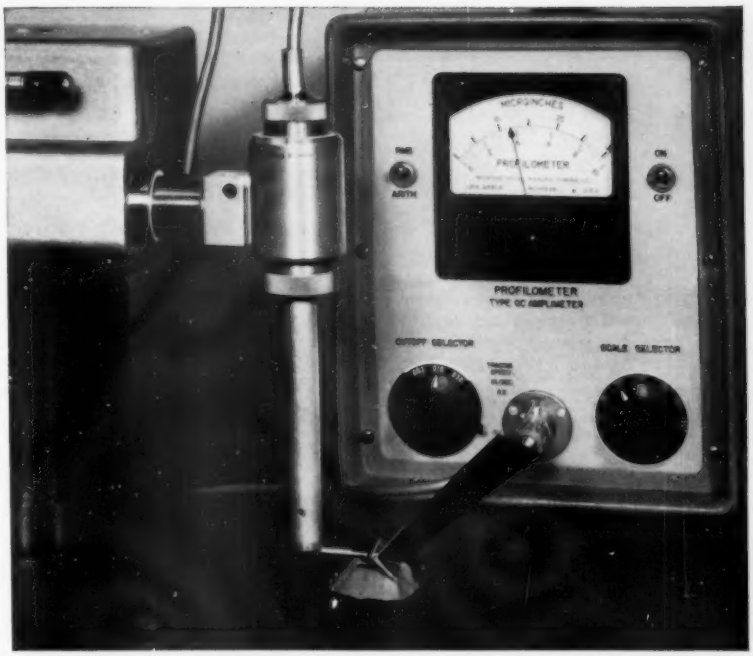
Jig Borer

Improved in several ways, the Hauser jig borer has an increased weight of 7700 lb, providing greater rigidity of base, table, boring head and other components. Spindle motor power has





PERTINENT QUESTION:

WHY do you need the Profilometer®?

FACTUAL ANSWER:

To check practically *all* surfaces against microinch roughness specs —and to help cut production costs in 7 different ways.

FREE BULLETIN LT14 gives details on the Profilometer and its practical applications. May we send you a copy?

MICROMETRICAL MMC® MANUFACTURING COMPANY
345 S. MAIN ST. ANN ARBOR 3, MICHIGAN

Manufacturer of the PROFILOMETER®, PROFICORDER®, MICROCORDER®, WAVOMETER®, ANDEROMETER®, VAROMETER®, CHART VIEWER • Exclusive American Sales Agent for CENSOR Dimensional Gaging and Sorting Equipment

Use Reader Service Card, CIRCLE 41

been increased from three to four hp. Additional table supports assist in carrying the load of table and workpiece on the guideways. The boring spindle has infinitely variable speed of from 10 to 430 rpm and from 50 to 2000 rpm. Reversible speed of the main spindle allows for tapping operations. Power operated tool clamping is automatic and provides proper torque. A knob that fine-sets to tenths eliminates tapping of the handwheel for fine adjustment.

Carl Hirschmann Co., Inc., 30 Park Ave., Manhasset, Long Island, N. Y. **Circle 328**

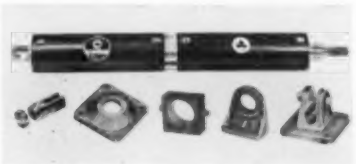
Epoxy Formulations

Complete line of formulated epoxy resins includes Foundcast 101 for molds and patterns; Sandbind 201 for making molds for casting epoxy duplicates; Facecoat 301 for use with epoxy molds and patterns; Multicast 401 for making epoxy jaws and chucks; and Layup 501, which is used to make epoxy molds and patterns with fiberglass layups. Surepart, a fluorocarbon dispersed in a liquid vehicle is stable over a temperature range from −60 to 450 deg F and is suitable for use as a parting agent with a wide variety of materials.

Allaco Products, 238 Main St., Cambridge 42, Mass. **Circle 329**

Tandem Cylinders

Advantages of hydraulic control are made possible in a line of Model BT air-operated cylinders that provide for the use of hydraulic fluid in either the front cylinder or in the center section of the unit without a makeup chamber. The units consist of two cylinders with a common head at the center and two



separate pistons mounted on one solid rod. Full speed control is obtained by piping flow control valves in series with the two ports used for the hydraulic section. Use of pressure in both sections doubles the force available and permits use of the units in small spaces. The cylinders are made in bore sizes of 1½, 2, 2½, 3 and 4 inches in lengths up to 80 inches and with a choice of mounts.

Allenair Corp., 255 E. 2nd St., Mineola, N. Y. **Circle 330**

Two-Pressure Control Valve

Model 1056 is a two-pressure control valve for in-line installation in hydraulic power tool 3000-psi systems.

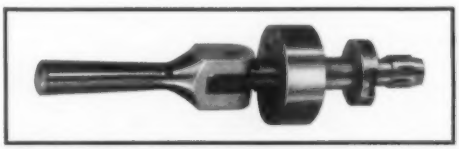
The unit allows conversion of existing hydraulic fastener installation tooling for double-drive applications. Fabricated of aluminum alloy, the valve weights 11½ oz and is 4¼ inches long by

LOCATION TOLERANCES OF .0004"

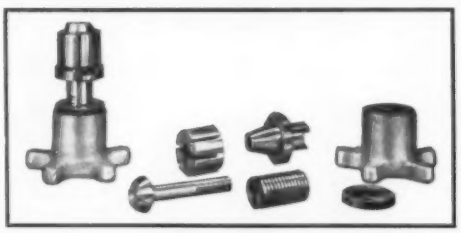
with SPEEDGRIP expanding locators

Gain accuracy—Save time—Avoid errors in loading or unloading work from fixtures! Speedgrip expanding locators are *guaranteed* to repeat fixture location within .0004". Nationally known customers find Speedgrip locators indispensable for holding required tolerances! Assures easier loading and unloading of work.

No. 0 Speedgrip Locator with cam lever actuation. With corresponding bushings, this locator will accommodate bores from 1/2" to 3/4" dia.



No. 2 Locator with hand knob actuation. With expansible bushings, this locator can be used for bores from 1" to 2" dia.



This No. 5 locator can be supplied for either wrench or draw bar actuation. Has precision ground pilot on under side of flange for mounting to fixture. With expansible bushings, this locator can accommodate bores ranging in size from 5" to 11" dia. Locators, with various means of actuation can accommodate bores, ranging from 3/8" to 11".

Some Open Territory • Dealer Inquiries Invited

FREE! Write for Bulletin No. 27 for full description and technical details.

SPEEDGRIP CHUCK
Division of ERNEST, HOLDEMAN & COLLET, INC.
Elkhart, Indiana

Use Reader Service Card, CIRCLE 42

1¾ inches wide by 1⅛ inches high. It is easily installed and mounts between the throttle valve and distributor valve assembly. The valve has a dual-pressure selection knob and a low pressure adjustment knob that permits selection of any pressure between 600 and 1400 psi. It can be used with six of the manufacturer's hydraulic power tools.

Huck Mfg. Co., 2480 Bellevue Ave., Detroit 7, Mich. **Circle 331**

Gear Deburring Machine

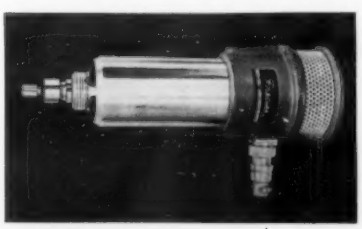
Model 36 will deburr and chamfer large spur, helical, worm and bevel gears and splines. A floating wheel automatically follows the contour of

the tooth. No wheel dressing, change gears or followers are required. The machine can handle external gears up to 36 inches and internal gears to 32-inches pitch diam. The work spindle can handle a load of more than one ton. The 1250 steel gear illustrated was deburred in a time cycle of two minutes per side.

Redin Production Machine Co., 2433 20th St., Rockford, Ill. **Circle 332**

Power Quills

Depending on the generator used, the power quill illustrated can operate at speeds of 14,000; 19,800; 28,800; 39,-600 rpm—or 19,800; 27,000; 39,600 and 54,000 rpm. Maximum power is ¾ hp. The quill uses type P collets with ¼-inch max capacity. Model 70 operates at constant speed under load in a range of from 7200 to 39,600 rpm; uses type P7 collets with a ⅜-inch max capacity; and has power output at the chuck of 1½ hp. Model 80 can operate at speeds of from 7200 to 21,-600 rpm; has maximum power of 2 hp; and uses type P8 collets with ½-inch max capacity.



Precise Products Corp., 3715 Blue River Rd., Racine, Wis. **Circle 333**

Tool Blanks

Dovetail form and shave tool blanks for automatic bar machines are available in either M-2 high-speed steel or T-5 super high-speed steel. All surfaces are ground and the blanks are heat-treated for maximum cutting life.

The Somma Tool Co., Inc., 109 Scott Rd., Waterbury, Conn. **Circle 334**

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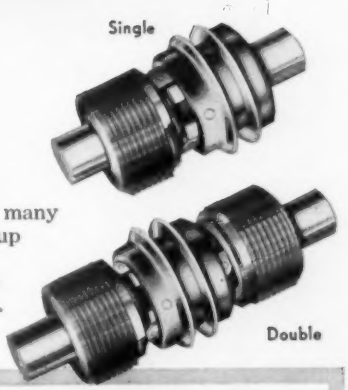
Dependable
PULLMORE
Multiple Disc
CLUTCHES

Compact, symmetrical in design Pullmore Clutches fit easily into many machine applications. They pick up the load smoothly to start, shift, reverse or brake motion. Manufactured in single or double types . . . call or write for details.



ROCKFORD CLUTCHES
ROCKFORD CLUTCH DIVISION BORG-WARNER

1329 EIGHTEENTH AVE.
ROCKFORD, ILLINOIS

Export Sales
Borg-Warner International
36 So. Wabash, Chicago, Ill.

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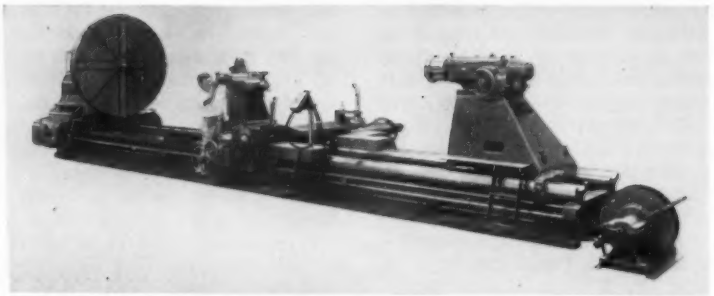
Engine, Tracer Lathe



Designed to handle work up to 40 tons, this medium duty engine and tracer lathe will make cuts of ¾ inch in depth. It is available in four sizes with swings from 74 to 108 inches over the bed. The 56-inch wide bed has four hardened and ground replaceable V-ways. Standard equipment for both lathes includes an internally geared face plate drive, pendant controlled operation including apron feed clutches, a 7½-inch diam tailstock spindle and traveling operator platform. The tracer lathe has an angle tracer slide with hydraulic actuating cylinder, a periscope type precision optical viewer, template holder brackets and adjustable supports for flat templates.

The American Tool Works Co., Pearl St. at Egglestone Ave., Cincinnati 2, Ohio. **Circle 335**

Induction Heating Machine

Rapid heating of this machine provides short cycle time for high production operation or incorporation directly into production lines. Modular design of the generator, control and heating stations permits transfer of units from one production line to another. The dual-unit construction of the control

station allows back-to-back or side-to-side mounting or, without field supply and motor starter, the control panel can serve as a remote meter panel with any heating station. A vernier calibrated timer assures close control of temperature range for uniform heat pattern from piece to piece. Portable heating station is available in 7½ to 30 kw with high-frequency line contactor station. The 50-kw model does not have a contactor.

Meta-Dynamics Div., The Cincinnati Milling Machine Co., Cincinnati 9, Ohio. **Circle 336**

Electronic Compensator

Buff or wheel wear in high production rate finishing operations can be com-

Use Reader Service Card, CIRCLE 44

pensated for by an adjustment device that results in reduced wheel wear, gives a more uniform finish and lowers high compound costs. The unit is completely and automatically controlled through ampere flow. Compensating vertical, horizontal or in-line adjustment to the buff or wheel takes place as the amperage flow to the sensing load detector varies. The highest operating efficiency level can be continuously held by setting the optimum amperage range. Control relays and timers furnish rapid response or delayed action as required.

Packer Machine Co., 456 Center St., Meriden, Conn. **Circle 337**

Superfinishing Machine

Model 51B is a general purpose finishing machine to which a second vertical platen can be added to permit the finishing of as many as four different areas simultaneously. The primary

platen has a self-contained reciprocating unit on which one or two stone-carrying quills can be mounted. Work is held between centers in a chuck, collet or fixture, or is supported on rollers. The tailstock and platen are mounted in V-slots for easy positioning along the bed.

Gisholt Machine Co., 1245 E. Washington Ave., Madison 10, Wis. **Circle 338**

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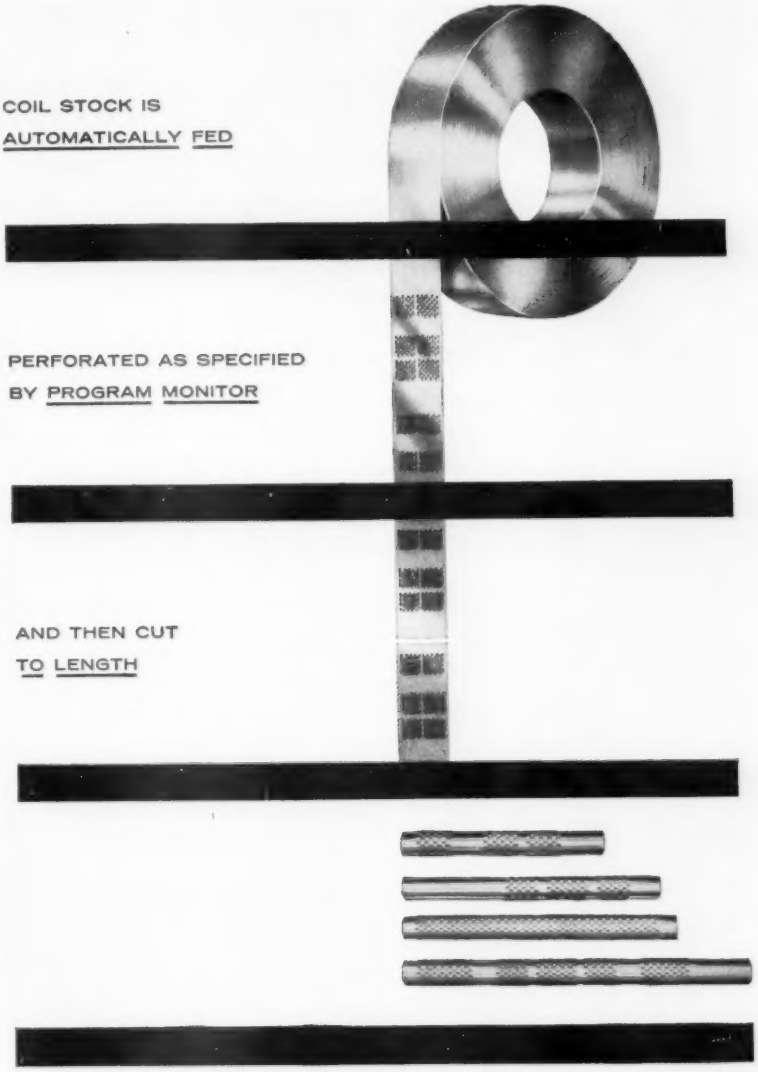
Ceramic Gages

Long-wear life, high-abrasion resistance, low coefficient of friction, low affinity for metals and low-thermal conductivity are among advantages of a line of ceramic gages. Maximum strength and surface finish are provided in plain and threaded plugs and plain ring gages made of high-density, high-purity aluminum oxide. In one example of performance, a ¼-inch 56 ceramic



PROGRAMMING WITHOUT TAPE WITH ONE SET OF TOOLS

Skip punching device, actuated by a repeating type counter, programs production of automotive muffler tube blanks in standard V & O inclinable press. Auxiliary counter controls blank cut-off. Varying perforation patterns are achieved with one set of tools. Integrating standard type mechanisms such as these to effect cost reduction illustrates the keen abilities that Emhart press experts can apply to your work improvement projects.

Emhart Manufacturing Co.
Hudson Div., Hudson, N.Y.
Formerly V & O Press Div.

EMHART

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modern MACHINES *demand*

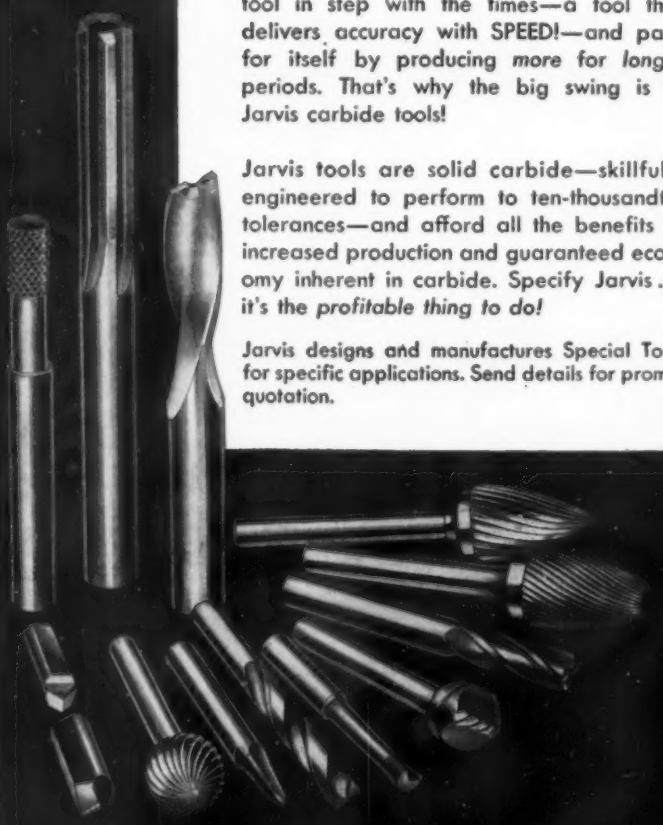
MODERN *solid carbide* **TOOLING!**

Jarvis SOLID CARBIDE GIVES MAXIMUM EFFICIENCY AND ECONOMY!

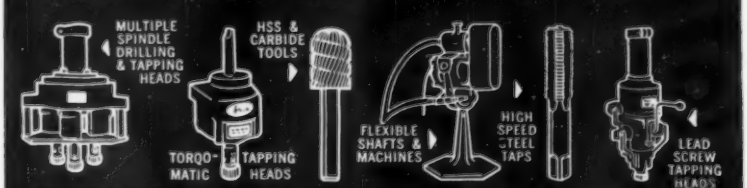
Forward-thinking management demands a tool in step with the times—a tool that delivers accuracy with SPEED!—and pays for itself by producing *more* for *longer* periods. That's why the big swing is to Jarvis carbide tools!

Jarvis tools are solid carbide—skillfully engineered to perform to ten-thousandths tolerances—and afford all the benefits of increased production and guaranteed economy inherent in carbide. Specify Jarvis... it's the *profitable thing to do!*

Jarvis designs and manufactures Special Tools for specific applications. Send details for prompt quotation.



NOTE: SOME AREAS ARE OPEN FOR REPRESENTATIVES OF OUR SOLID CARBIDE TOOLS


MULTIPLE SPINDLE DRILLING & TAPPING HEADS
HSS & CARBIDE TOOLS
TORQO-MATIC TAPPING HEADS
FLEXIBLE SHAFTS & MACHINES
HIGH SPEED STEEL TAPS
LEAD SCREW TAPPING HEADS

JARVIS CORPORATION • MIDDLETOWN, CONNECTICUT

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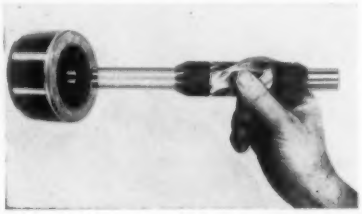
taper lock thread plug, gaging AMS-4017 aluminum nuts, completed 100,000 pieces with 60 percent wear life remaining. Types available in the line are thread plug gages No. 6 through 1½; plain plug gages 0.100 through



1½; plain ring gages 0.070 through 1½; and plain master disks 0.105 through 1½. All gages made on special order.

Greenfield Tap & Die Corp., Greenfield, Mass. **Circle 339**

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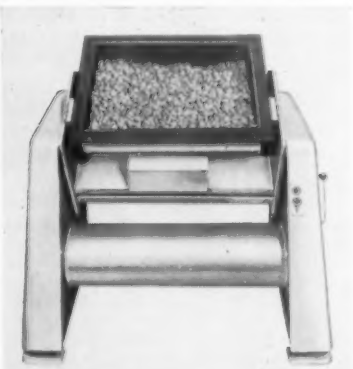
Vibratory Finishing Machine

Usable as a vibrator for mixing, pulverizing, deburring, descaling, cleaning and screening or for the surface refinement of metal parts, this machine provides maximum tumbling with minimum movement and current consumption. The unit is portable since vibration is limited to the tub, with a negligible amount transmitted to the base.



Suspension design permits angular positioning of the tub, while maintaining vibration of the media and parts in any position. Inverted, the tub serves to screen materials, and provisions are made for obtaining varied flow of parts and amplitude of vibrations. Downtime is minimum, since belts or pulleys need not be changed and there is no need to start, stop or reverse motors.

Stevenson Co., Wellsville, Ohio. **Circle 340**

Trade Literature

for free booklets and catalogs—use request card, page 135

ONE THOUSAND TOOL and die plants, arranged by state and city, are listed in the 1960 Directory of Special Tooling Services. National Tool and Die Manufacturers Assn. **(Circle 401)** . . . Two companion slide calculators useful in metalworking applications are available without charge. Adamas Carbide Corp. **(Circle 402)** . . . Details of a program to solve the problem of variables in the verification of output of power tools are outlined in a four-page brochure. Skidmore-Wilhelm Mfg. Co. **(Circle 403)** . . . A comprehensive report is designed to aid companies in determining the economic feasibility of maintaining their own screw machine departments. National Screw Machine Products Assn. **(Circle 404)** . . . Available without charge, the 1960 Price List and Index of American Standards lists nearly 1900 American standards approved to date. American Standards Assn. **(Circle 405)** . . . Line of special purpose machines for manufacturing small, high-precision parts is described in a 31-page book in German language **(Circle 406)** or French language **(Circle 407).** Henri Hauser Ltd.

Automation

Two-page bulletin details sequence programmer MSP-1 for timing and cycling of automated machinery or semiautomatic work functions with air or electricity. Clippard Instrument Laboratory. **(Circle 408)** . . . Management-oriented, 16-page bulletin, "Automation and You," discussed technology, equipment and economics of automation. General Electric Co. **(Circle 409)** . . . Literature explains the concept of flexible and versatile automation equipment and how it is embodied in the manufacturer's TransfeRobot parts assembler. USI Robodyne Div., U. S. Industries, Inc. **(Circle 410)**

Boring, Drilling, Tapping & Threading

Numerically controlled drilling machines are described in a four-page folder. Lahr Machine & Tool Corp. **(Circle 411)** . . . Automatic, high-speed drilling, tapping and threading machines are described and illustrated in a 12-page catalog. Universal-Automatic Corp. **(Circle 470)** . . . Eight-page, illustrated bulletin DV-1 covers the application of a five-chaser threading tool. Threading Tools Div., National Acme Co. **(Circle 412)** . . . More than 22 varieties of tools are illustrated and described in 68-page catalog No. 60. Caicago-Latrobe. **(Circle 413)** . . . Bulletin G-94-2 describes and illustrates style ALT collapsible taps. Landis Machine Co. **(Circle 414)**

Broaching

Twelve-page, illustrated catalog B60-4 describes Red Ring broaches and broaching fixtures. National Broach & Machine Co. **(Circle 415)**

Cleaning

Two-page data sheet covers a noncorrosive alkaline metal cleaning compound. Metasurf Corp. **(Circle 416)**

Coolants

Four-page, illustrated bulletin DP 114 describes applications and operation of one of a line of filters for industrial fluids. Commerical Filters Corp. **(Circle 417)** . . . Latest edition of "Die Headlines" is a detailed presentation of data on cutting oils. The Eastern Machine Screw Corp. **(Circle 418)** . . . Technical brochure No. 46 OB discusses cost reduction in machining operations through proper use of cutting fluids and coolants. Master Chemical Corp. **(Circle 419)**

Cutting Tools & Holders

Manual No. 59 is a catalog and price list of both standard and special carbide tools. Precision Carbide Co. **(Circle 420)** . . . Nine high-velocity applications of disposable inserts made of Kentanium Grade 165 are tabulated with comparative performance records in a two-page bulletin. Kennametal Inc. **Circle 421)** . . . Automatic recessing tools are discussed in the company's brochure. Madison Industries, Inc. **(Circle 422)**

Explosive Forming

A method of shaping metal parts by means of explosive energy is detailed in four-page technical bulletin No. 4. Propellex Chemical Div., Chromalloy Corp. **(Circle 423)**

Fasteners

Data sheet describes a special fastener for use where the strength of a bolt is required along with fast opening and closing. Simmons Fastener Corp. **(Circle 424)** . . . Eight-page booklet, "One Piece Self Locking Screws and Bolts," explains advantages of Holtite Nylok screws. Contintental Screw Co. **(Circle 425)**

Finishing & Grinding

Catalog M1501 describes a line of diamond wheels and provides data on available grit sizes and diamond concentrations, wheel markings, suggestions to prolong service life, and ordering and price information on both resinoid bonded and metal bonded wheels. Abrasive Wheel Dept., Manhattan Rubber Div., Raybestos-Manhattan, Inc. **(Circle 426)** . . . Current issue of "Diamond Data" discusses relative technical and economic advantages of finish grinding, honing and lapping with natural diamond as compared with other abrasives in an article titled "Super-Finishes and Super-Precision with Diamond" by John H. Olson. Industrial Diamond Div., Engelhard Hanovia, Inc. **(Circle 427)** . . . Eighth data sheet of a series on abrasive finishing methods and materials for copper plate discusses buff speeds, type of buff, proper liquid or bar abrasive compound and working hints. The Lea Mfg. Co. **(Circle 428)**

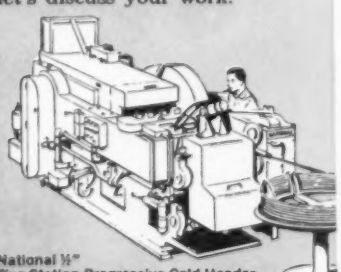
Fluid Power

Manual or electrically operated and remotely controlled pressure regulators of the RV-23 series are covered in a 12-page brochure. Marotta Valve Corp. **(Circle 429)** . . . Bulletin SQ-3-60 provides 16 pages of technical information on an air-hydraulic cylinder. The Tomkins-Johnson Co. **(Circle 430)** . . . Catalog and engineering guide No. 116 describes a line of air-hydraulic, interchangeable boosters and tanks. The S-P Mfg. Corp. **(Circle 431)** . . . Sixteen-page form 360 contains full-size tracing templates of a line of small-size cylinders in medium and high-

These important parts are cold-formed from coiled wire, start to finish in compact, efficient National Cold Headers.

Three are formed with no scrap loss. Two are ready to use! All five achieve remarkable savings over past methods.

If you make odd-shaped parts, may we help you evaluate them for cold-forming from wire? Better yet, come to Tiffin, witness our demonstrations and let's discuss your work.



National ½" Five-Station Progressive Cold Header

NATIONAL MACHINERY CO.

TIFFIN, OHIO, U.S.A.

HARTFORD DETROIT CHICAGO

Use Reader Service Card, CIRCLE 47

Trade Literature

pressure ranges. Control Equipment Line. **(Circle 432)** . . . Complete lines of air cylinders, valves, clamps and dial feed tables are illustrated in an 88-page catalog. Allenair Corp. **(Circle 433)**

Gears & Gearmaking

"Essentials of Rotary Gear Shaving" is an 18-page presentation of basic gear production and shaving information. National Broach & Machine Co. **(Circle 434)** . . . Catalog sheet CS60-1 describes improved equipment and processes for shaving engine camshaft gears. National Broach & Machine Co. **(Circle 435)**

Heat & Chilling

Advantages and design features of a standard gas-fired or electric box type recirculating furnace are described in bulletin SEC-8. Sunbeam Equipment Corp. **(Circle 436)** . . . Large capacity production chilling equipment for stabilization of metals, stress relief of castings, dehydration of gases, expansion assembly and other applications is described and illustrated in a two-page data sheet. Cincinnati Sub Zero Products **(Circle 437)**

Inspection & Measurement

Two lines of static-dynamic balancing machines are described in 20-page bulletin 60. Tinius Olsen Testing Machine Co. **(Circle 438)** . . . Illustrated, eight-page booklet describes a line of checking gages. Cadillac Gage Co. **(Circle 439)** . . . New approaches to gaging problems are pictured and explained in a four-page booklet. Deltronic **(Circle 440)** . . . Bulletin 205-60 gives applications, product features, specifications and operational data on an autocollimator for precision measurement of angular position and small linear displacements. Gaertner Scientific Corp. **(Circle 441)** . . . Four-page folder, "Electronic Fluoroscopy and High Speed Motion Picture Photography Used in the Evaluation of Sealed Assemblies," describes how units under test can be evaluated during functional conditions such as simulated high frequency vibration. Philips Electronic Instruments **(Circle 442)** . . . "Norelco Non-Destructive Testing Equipment" is a 12-page booklet containing engineering facts and specification for many X-ray test units for radiography and fluoroscopy. Philips Electronic Instruments **(Circle 443)**

Lathes

Model HD 2013 heavy duty lathe is described and illustrated in 12-page bulletin No. 212. Nebel Machine Tool Corp. **(Circle 444)**

Milling

Three sizes of portable equipment for milling, drilling, slotting, boring, shaping, grinding and related machining operations on varied work sizes is detailed in bulletin VM-60. The Dumore Co. **(Circle 445)** . . . Throwaway insert milling cutters and a long-life blade are described in two-page bulletin TA-7888. Wesson Co. **(Circle 446)** . . . Hydraulic tracer control for milling machines is described in a four-page specifications bulletin. Tree Tool and Die Works **(Circle 447)**

Numerical Control

Sixteen-page bulletin No. AP-60, "Around a Part in Just Eight Days," presents the story of how a job was processed from print to finish-machined part. Kearney & Trecker **(Circle 448)**

Plastics

Industrial applications for epoxy resins are detailed and illustrated in a pamphlet titled "The Role of the Epoxy Resin Formulator in the Plastics Industry." Ren Plastics, Inc. **(Circle 449)** . . . Sixteen-page catalog and price list covers a complete range of materials for fibrous glass reinforced plastics. Cadillac Plastics & Chemical Co. **(Circle 450)** . . . Ten cost-saving applications are outlined in an eight-page brochure that deals with tooling plastics in the foundry. Furane Plastics Inc. **(Circle 451)** . . . Two phenolic molding materials with fast cure times and wide molding latitudes are described in technical release No. 40. Union Carbide Plastics Co. **(Circle 452)**

Plastics Molding

Bulletin 291 contains specifications for model 853-1 dual manifold blow molding machine. F. J. Stokes Corp. **(Circle 453)**

Plating & Painting

Illustrated booklet, "How to Stop Rust with 'Duco' Metal Finishes," explains the proper use of metallizing primers and paints. E. I. Du Pont De Nemours & Co. **(Circle 454)** . . . Bulletin No. AC-112 describes and illustrates a line of anodes, anode accessories and chemicals for electroplating and metalfinishing. Hanson-Van Winkle-Munning Co. **(Circle 455)**

Pressworking

Bulletin No. 85-60 illustrates and describes units in a line of automatic press room equipment. U. S. Tool Co., Inc. **(Circle 456)** . . . Sixteen-page bul-

letin No. 52200 details a line of piercing, notching and blanking presses. The Federal Machine & Welder Co. **(Circle 457)**

Sawing

Vertical band sawing machine is described and illustrated in an eight-page catalog. The DoAll Co. **(Circle 458)**

Shears

A two-page data sheet describes blade action in shearing of bar stock and angle iron. The Shearease Co., Inc. **(Circle 459)**

Spindles & Heads

Pocket-size, 36-page bulletin S-18 illustrates and describes more than 60 different types of spindles, spindles arranged for electrolytic grinding and two new boring machines. Pope Machinery Corp. **(Circle 460)**

Switches, Relays & Solenoids

Sixteen-page illustrated bulletin EC-SL-260 describes and shows new limit switches. The National Acme Co. **(Circle 461)** . . . Bulletin GEA-7086 describes a foot switch used with punch presses, riveting machines, resistance welding, machine tools, machines for bending and forming, and in control circuits as a pilot device. General Electric Co. **(Circle 462)**

Tool Steels

Twenty-eight-page index reference, "Tool Steel Comparison Guide," lists tool steels according to AISI-SAE classifications, trade name and number. Peninsular Steel Co. **(Circle 463)**

Welding, Brazing & Soldering

Cost saving potential and metallurgical advantages of cutting stainless steel plate by a tungsten arc process are described in an illustrated folder. Steel Warehousing Div., Jessop Steel Co. **(Circle 464)** . . . Four-page bulletin discusses a variable speed induction heating turntable. McDowell Electronics, Inc. **(Circle 465)** . . . Automatic arc welding machines are detailed in eight-page bulletin 8-513A. The Taylor Winfield Corp. **(Circle 466)**

Workholding

Collets and collet fixtures are described and illustrated in a four-page bulletin. Zagar, Inc. **(Circle 467)** . . . Bulletin No. 102105 covers miniaturized toggle clamps. Detroit Stamping Co. **(Circle 468)** . . . A cam locking jig vise, controlled flow coolant pump and tank unit, and soft chuck jaws are detailed in a four-page folder. Morton Tool Co. **(Circle 469)**

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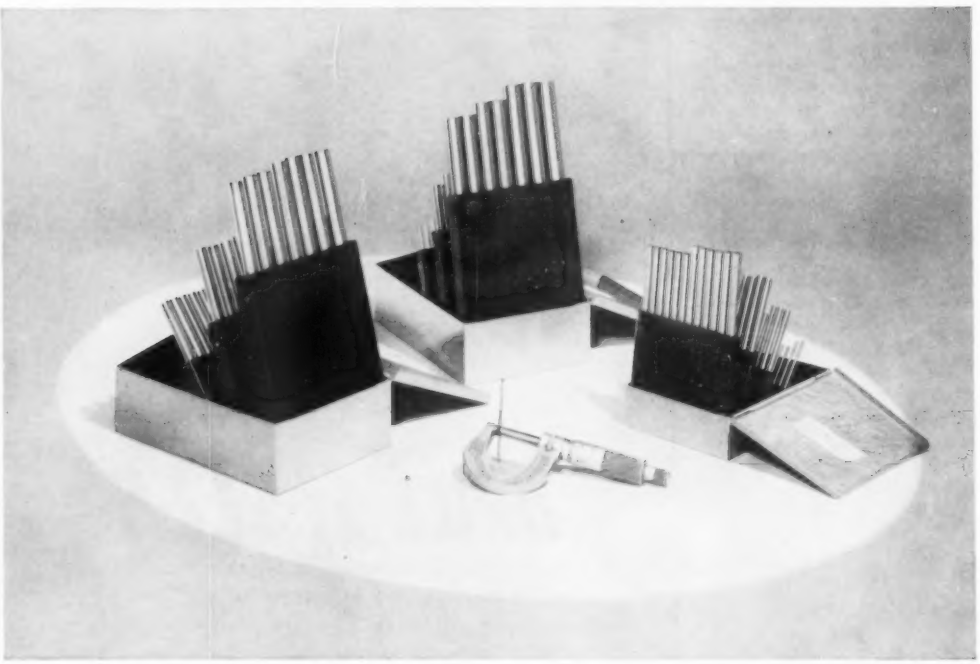

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Robert B. Ryan, left, formerly vice president, has been elevated to the post of president of The McLaughlin Co., Birmingham and Petoskey, Mich., He has been with the company for 10 years. Action of the board of directors has also promoted Robert D. Martin, former secretary-treasurer of the company, to the position of vice president. He has been with McLaughlin for eight years.

Lawrence H. Cousineau, right, has been elected president of the Heald Machine Co., Worcester, Mass. He succeeds C. F. Roby who recently retired from the presidency. Cousineau, who has been with the company for 14 years, has served as a director since 1955 and is also currently serving as administrative vice president of Heald's parent company, Cincinnati Milling Machine.

Men at Work

The board of directors of P. R. Mallory & Co. Inc., Indianapolis, Ind., has announced the election of G. BARRON MALLORY to the office of president, succeeding JOSEPH E. CAIN.

CLARENCE B. REX has been elected vice president of U. S. Industries, Inc. He continues as treasurer of the company, a post he has held since early 1958.

WILLARD H. SPENCE has been elected vice president and general manager-Industrial Products Div., Brown & Sharpe Mfg. He will also continue, for the present, in his responsibilities as managing director of Brown & Sharpe, Ltd., the company's British manufacturing subsidiary in Plymouth, England.

LOUIS POLK, JR., has been appointed vice president of operations for the Sheffield Corp. He will be responsible for research, engineering, manufacturing and sales of the company's three product divisions.

JAMES W. HOPPER has been named assistant to the president, Pratt & Whitney Co., Inc. He joined the company in 1951 as a gage sales engineer. In 1955, he was named gage application engineer, specializing in continuous gaging and automatic mill and machine control. Four years later, in 1959, he was made Washington representative, dealing with government business for Pratt & Whitney.

ELWOOD HEMLIN, factory manager of R-O Mfg. Co., producers of form relieving equipment, has been elected vice president of the company.

U. N. Alloy Steel Corp. has announced the appointment of RICHARD L. DUNCAN as product manager of the company's hot work tool steel division. Duncan comes to his new post with a background of 15 years experience as an extrusion tool engineer.

A. WILLIAM TILDER, formerly general manager of the Acromatic Tool Co., Detroit, has been named general manager of the Morton Machine Works Div., Brubaker Tool Corp.

Merrill A. Hayden, general manager of the Machinery Hydraulics Div., Vickers, Inc., has been elected a vice president of the company. He became general manager of the division when it was formed in 1957. For 10 years preceding that appointment, Hayden was with the Waterbury Tool Div. of Vickers, serving in many managerial positions.

Robert C. Dickey has been named vice president and general manager of Coated Abrasives, Inc., Warren, Mich. He has been plant manager at Michigan Abrasive Co. and will remain on the staff of that company as manufacturing process consultant. Dickey is a graduate mechanical engineer of Pennsylvania State University, attended Buffalo and Princeton.

Lawrence M. Weitzel has been elected president of Mechanical Specialties Co., Los Angeles, Calif. He succeeds the late Carl T. Weitzel. Weitzel joined the company in 1941 as tool crib attendant and worked in all plant departments. He became a vice president in 1952. The tooling and machining company builds ground-handling equipment.

Melvin D. Verson has been appointed president and chief operating officer of the Verson Allsteel Press Co., Chicago, Ill. Other appointments announced by the company's board of directors include that of Jack Novak, executive vice president, to the additional position of secretary of the corporation. David C. Verson will function as chief executive officer.

"The fabulous '60s, with tremendous technological advances predicted, will require this type of perfectionist precision tool . . . and, son—

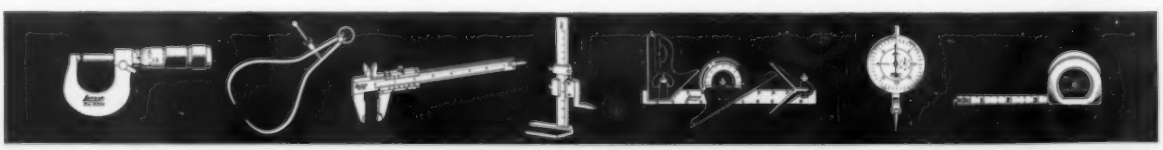
only Lufkin offers you a decimal radius gage!"

This unique radius gage is an excellent example of why Lufkin is the new leader in precision tools. It is designed to save the craftsman time and effort . . . to give him greater accuracy with readings from .010 to 1.000, and no burrs to throw him off.

Hardened stainless steel blades, too, for a lifetime of accurate service. And the holder for this No. 75 gage is 4½" long, reaches into small, out-of-the-way places. Adjusts over 180° arc to keep blade edge perpendicular to surface measured.

Durable vinyl case holds blades in individual pockets, makes selection fast and easy.

See your industrial distributor. He knows precision tools and can show you how Lufkin leads in design and craftsmanship. His stock is maintained to fit your needs. LUFKIN, Saginaw, Mich.



Field Notes

The Board of Directors of the **Hertz Engineering Scholarship Foundation** announced at its annual meeting in Los Angeles that future scholarship activities, beginning with 1961 grants, will be expanded to include all fields of engineering. Previously the Foundation granted scholarships only in electrical and mechanical engineering. Graduates in these two fields currently account for about half of all engineering bachelor degrees awarded annually. The addition of the remaining engineering fields to the present coverage of electrical and mechanical engineering will enable the Foundation to make its scholarship selections on a much broader basis.

expansions

A $1,250,000 improvement and expansion program, which will substantially accelerate production at the **H. M. Harper Co.**, Morton Grove, Ill., will be completed sometime in July according to H. M. Harper, Pres. The expansion program, which was started in January, 1959, includes the construction of four building additions containing approximately 26,000 sq ft of floor space and a variety of new equipment for Harper's production of stainless steel alloys.

Taylor Fibre Co. will spend in excess of $500,000 in 1960 as part of a four-year $2,000,000 capital expansion and improvement program. The half million dollar capital expenditure predicted for 1960 is the largest in recent years and compares with $382,000 for 1959, when the four-year expansion program got underway.

new facilities

Machlett Laboratories, Inc., a division of Raytheon Co. will build an expandable 120,000-sq ft plant on a 100-acre site it has purchased in Winsted, Conn. Completion of the facility is scheduled for 1961.

A new division providing complete facilities for production of quality spur, helical and bevel gears and splines for use in prototypes and in developmental quantities has been announced by **Michigan Tool Co.**, 7171 E. McNichols Rd., Detroit. The new "Enterprise Division" has been formed by combining a number of previous facilities with newly acquired facilities of the former Enterprise Gear and Tool Corp.

Construction of a new plant will begin immediately at Des Plaines, Ill., to house the new Conex Div. of **Illinois Tool Works**, Chicago. The new division will manufacture thin-wall plastic containers and other packaging products.

Sundstrand Machine Tool Div. of Sundstrand Corp., Rockford, Ill., has opened a new methods laboratory for testing electrical discharge machining. Primary intent is for proving applicability of EDM to machining problems, although a subcontracting service for job lot runs is also available. Samples can be machined to enable giving reliable production estimates as well as to prove limits and finish obtainable.

acquisitions

Hale Fire Pump Co., Conshohocken, Pa., has purchased the accumulator business of Narda Hydraulics Corp., Westbury, L. I. Engineering, manufacturing, testing and sales will be handled at the two Hale plants in Conshohocken.

The Cincinnati branch of Yale Materials Handling Div., The Yale & Towne Mfg. Co., has been purchased by the newly formed **Moon Equipment Co.** according to a joint announcement by Harold E. Moon, president of the new company, and Louis W. Jander, Yale general sales manager. Moon Equipment Co. will maintain headquarters at 9880 Springfield Pike as the franchised representative for Yale industrial lift trucks and tractor shovels in southwestern Ohio and northern Kentucky.

The Skinner Chuck Co., New Britain, Conn., has announced acquisition of the Horton chuck line from the Geometric-Horton Div., United-Greenfield Corp., New Haven, Conn. The transaction includes the purchase of chuck trade names and trademarks, machinery, jigs, fixtures, inventory, drawings and patents of the Horton chuck line.

Ex-Cell-O Corp., of Detroit has purchased the sine plate business of the Omer E. Robbins Co., according to an announcement by H. Glenn Bixby, Ex-Cell-O president. The newly acquired products include a line of Magna-Sine magnetic sine plates or chucks as well as nonmagnetic sine plates used for inspection work. These products further supplement and diversify the Ex-Cell-O line in the metalworking and gaging fields.

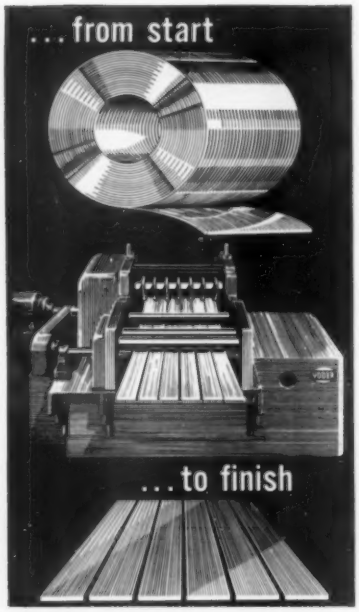
awards

Dr. Thomas R. O'Meara, a Hughes Aircraft Co. electrical engineer, has received the first **Dr. William G. Tuller Memorial Award** May 10, the company announced. The award is in recognition of the most outstanding technical paper dealing with electrical component parts published in professional journals in 1959.

Dr. O'Meara's paper was described as "one of the first general studies of the common methods of extending low frequency transformation to high frequency, wide band operation using a lumped parameter, wide band, high-frequency transformer."

A paper summarizing results of the Corrosion Research Program conducted by the Alloy Casting Institute at Ohio State University has earned the **1959 Young Author Award** for Dr. N. D. Greene, Jr. Presented to Dr. Greene at the 16th annual conference of the National Association of Corrosion Engineers in Dallas, Texas, the award is given annually for the best technical paper published during the year in the Association's Journal.

Dean Kurt F. Wendt of the University of Wisconsin College of Engineering has been awarded the **Bliss Medal** for 1960 by the Society of American Military Engineers. The national award for achievement in engineering education was presented to Dean Wendt at the society's 40th annual meeting, held in the Mayflower Hotel in Washington, D. C., Thursday, May 19.



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If your slitting requirements call for coil widths from 12" to 60", in gauges from .015" to .250", the economy of purchasing Yoder Slitting Machinery can be yours. Operating a Yoder Slitting Line only one eight-hour shift per week, for example, could easily produce 35 tons of slit strands per week... or 1,820 tons every 52 weeks. At a slitting cost saving of only ½¢ per pound, the annual savings would amount to $18,200.

Additional savings can be realized through lowered inventory of mill-width coils – less waiting for delivery of special slit widths. Also, customer satisfaction will increase as you achieve faster completion and delivery of finished products.

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Send for Yoder's illustrated text on slitting operations and equipment. It describes methods, time studies, operating cycles, material handling, and gives full specifications.

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Field Notes

Robert K. Hopkins, vice president and general manager, steel division of Firth Sterling, Inc., has received the **Achievement Award in Metallurgy** for 1960 from the American Society for Metals, New York chapter. Hopkins invented the Hopkins process, a technique for producing ultrapure alloys by consumably remelting electrodes by striking an arc through a purifying slag in a water-cooled copper crucible. Firth Sterling purchased the process early last year from the M. W. Kellogg Co., Jersey City, N. J.

association news

The American Society of Lubrication Engineers announces the election of L. O. Witzenburg, Cleveland Worm & Gear Div., Eaton Mfg. Co., Cleveland, Ohio, as president of the 3000 member technical society. Prior to his election as president, Witzenburg served the society as vice president-at-large and industrial director.

John E. McIntyre, vice president and general manager, Sibley Machine and Foundry Corp., South Bend, Ind., has been elected vice president of **Gray Iron Founders' Society, Inc.**, Cleveland, to fill the unexpired term of J. E. Quest who has left the foundry industry. The Society's Board of Directors also appointed Mr. McIntyre a member of the executive committee to replace Mr. Quest.

Dr. Eric A. Walker, president of the Pennsylvania State University, is the new president of the **American Society for Engineering Education**. He will serve for the year beginning in July, 1960. Dean Melvin R. Lohmann of Oklahoma State University and Professor Newman A. Hall of Yale University have been chosen as vice presidents, and Wendel W. Burton of the Minnesota Mining and Mfg. Co. has been renamed treasurer.

The 1960 Greer Award will be formally presented June 6 to the Hughes Aircraft Co.'s Field Service and Support Div. in recognition of contributions to Department of Defense activities in the area of maintenance and product support. Established in 1956 by Greer Hydraulics, Inc., Los Angeles and New York, to stimulate thought and action of benefit to industry and the public by encouraging solutions to maintenance problems, the Greer Award is administered by the Maintenance Advisory Committee of the National Security Industrial Association.

new activities

In recognition of the growing importance of steel service centers, **Jones & Laughlin Steel Corp.** has announced a program of selling exclusively through its distributors. Under this program, to be known as Project 60, all promotional material supplied by J & L will bear the service center's name only. This new policy retains established customer relations although a customer may become large enough to order direct.

Syntron Co., Rectifier Div., Homer City, Pa., subsidiary of Link-Belt Co., has announced the appointment of **Dage Corp.**, 219 E. 44th St., New York City 17, as export representative. Dage will handle the complete line of Syntron silicon and selenium rectifiers in the world-wide market.

Keller Industrial Products Inc., 217 East Ave., Rochester 4, N. Y., is now franchised as a distributor for Parker industrial hose and reusable hose fittings. The products, furnished by the corporation's Parker Fittings & Hose Div., Cleveland, Ohio, are for industrial pneumatic and hydraulic applications.

A program for the construction of a 50 million dollar complex of chemical plants which would convert hydrocarbons into more than a dozen chemical products has been revealed by The Borden Co. and United States Rubber Co. The two companies announced that they are forming a jointly owned chemical company to be called **Monochem, Inc.** The new company will erect a major chemical manufacturing unit using hydrocarbons such as natural gas or low flash point liquid fuel as a starting point for the production of acetylene and vinyl chloride monomers.

Roy C. Ingersoll, chairman of **Borg-Warner Corp.**, and Oscar McKay, chairman of Ralph McKay Ltd., have negotiated a partnership arrangement whereby Borg-Warner, through a wholly owned Australian subsidiary, will acquire a 25.4 percent interest in Ralph McKay Ltd., Australian implement parts manufacturer.

Gisholt Machine Co., Madison, Wis., announces the appointment of Star Machinery Co. as a manufacturer's representative to handle distribution of the Gisholt line of machine tools. Star Machinery Co. maintains sales offices in both Seattle and Spokane, Wash., and in Portland, Ore. The territory assigned includes all of the state of Washington, and parts of Idaho and Montana.

technical shorts

Treated Diamond Grit

The Industrial Diamond Div. of Englehard Hanovia, Inc., has recently developed an improved natural diamond grit for use in grinding wheels. Unlike conventional diamond grit, the new grit, designated as SND, consists of a preponderance of needle-shaped and plate-shaped particles. Needle particles are defined as those which are at least twice as long as they are wide. Plates are those which are less than one quarter as thick as they are wide. By contrast, conventional grit contains particles of comparatively blocky proportions.

Because of their shape, SND particles are held more firmly in the bond of resinoid grinding wheels. In addition the particles prove more friable, and tend to break off a little at a time, constantly exposing new cutting edges. The characteristic of more even and complete consumption of diamond particles has led to further studies aimed at greater increases in friability and bond tenacity. As a result, a treatment has been developed which further improves the grit by creating surface irregularities in normally smooth crystals.

Treated SND particles are most effective in resinoid wheels subjected to infeeds of 0.0005 inch or less. Untreated particles are efficient at infeeds of 0.0005 to 0.0015 inch. At extremely heavy infeeds—0.003 inch and greater—conventional diamond grit remains the superior material.

* * *

Tantalum Bayonet Heater

Pfaudler Co., a division of Pfaudler Permutit, Inc., has built one of the largest bayonet heaters yet produced as part of a program for solving fluid handling problems. Consisting of 52 tantalum tubes 1½-inch OD by 72-inch in length, the heater is designed for use in a glassed-steel vessel being used as a nitric acid reboiler.

Use of tantalum and glassed steel together is appropriate because corrosion resistance of the materials is similar. Tantalum is fully resistant to all acids except hydrofluoric. Its ability to withstand corrosive attack at elevated temperatures is of particular importance in this application.

Fabrication of the bayonet heater was made possible by recent production developments at Pfaudler. During the course of fabricating a wide range of corrosion-resistant alloys, the company installed a "vacuum-purge" welding unit that eliminates the difficulty inherent in welding tantalum and other metals which combine easily with oxygen, nitrogen and hydrogen.

Vinyl-Based Solid Fuel

Recent declassification of the solid fuel propellant program of Atlantic Research Corp. of Alexandria, Va., has revealed vinyl resin as an ingredient of one of the solid fuels. Fire resistant at ordinary temperatures, polyvinyl chloride reacts with ammonium perchlorate to provide a high-energy release.

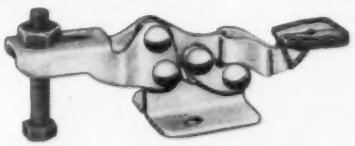
The propellant powers several rockets, among which are high-altitude meteorological probes such as the Arcon and Arcas. It also powers small rocket engines which perform spin and retro functions on large rockets and missiles.

At present a casting technique is used to produce solid fuel propellant. Future plans call for a continuous extrusion process using commercial equipment.

MINIATURE KNU-VISE CLAMPS DO MIGHTY JOBS

These tiny Knu-Vise toggle clamps are capable of exerting 100 to 150 Lbs. clamping force with a reach of 7/8 and 9/16 inch respectively in front of base. Other features are:

- **Clamping height, 19/32 above base.**
- **Double shear bearing pins prevent clamping spindle side-thrust or tilt.**
- **Largest diameter pins for size of clamp—80% minimum bearing area.**
- **When open, spindle head withdraws beyond front of base, permits vertical removal of largest parts.**
- **All models have replaceable grips.**

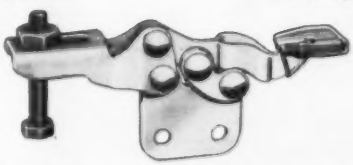


Four Models H-100 Twin-flange base

HL-100 Left-flange base

HR-100 Right-flange base

SH-100 Straight base for side mounting.



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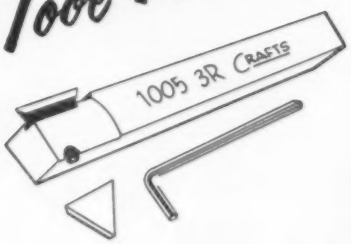
CRAFTS

NEW MECHANICAL *Tool Holder*



3/8"SQUARE-15°SHEAR

Crafts new #1005-9 Mechanical Tool Holders are ideal for Copper, Aluminum, Magnesium and Plastics.

These heat-treated shanks are made to accommodate inexpensive triangular Carbide Inserts — instantly indexable and easily replaced with hex wrench, furnished. Now stocked in 5 styles, Right and Left Hand.

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#1005-3 L (L.H.)

#1008-3 R (R.H. Shown)
#1008-3 L (L.H.)

#1009-3 R (R.H. Shown)
#1009-3 L (L.H.)

#1006-3 R (R.H. Shown)
#1006-3 L (L.H.)

#1007-3 R (R.H. Shown)
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ENGINEERING BOOKSHELF

OIL HYDRAULIC POWER AND ITS INDUSTRIAL APPLICATIONS—*By Walter Ernst. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y. Price $12.50. 460 pages.*

How oil power is generated, utilized transmitted, controlled and applied in industry is presented in this book. Intended to impart a well-rounded understanding of oil hydraulics, this second edition covers the field from the basics of fluid mechanics, through component and circuit design, to information on commercial equipment and hints for operation and maintenance.

The author deals with the aspects of fluid mechanics as applied to oil under pressure, oil flow characteristics, viscosity, and behaviour in hydraulic machinery. Each stage of the hydraulic system is discussed including the generation of power by rotary pumps, use in rotary and reciprocating motors, control, and transmission. How components are coordinated into a working mechanism is covered.

Attention is given to industrial applications of oil hydraulic power and a number of hydraulically operated machines—machine tools, presses, tracer-controlled machines and others.

The book includes new material covering such areas as: petroleum base and synthetic hydraulic fluids; hydrodynamic effects in rotating fluids; hydrostatic bearings; remote and closed-loop pump control; pump noise and vibration; transmission of hydraulic power; directional valve design; gasket-mounted units, and component standardization; and servomechanisms and servo valves.

HARDNESS: THEORY AND PRACTICE, PART 1, PRACTICE—*By Louis Small. Published by Service Diamond Tool Co., 2505 Burdette, Ferndale, Mich. Price $8.50. 549 pages.*

For anybody concerned with hardness testing, this complete summary of the state of the art should become a standard reference. Under one cover, Louis Small presents an exhaustive file of practical information on hardness

M1238-1818 — *Range 18" x 18", working distance 9" to infinity. Reads to 0.001" up to 24" working distance. Protractor ocular reads to 3 minutes of arc. Image is erect.*

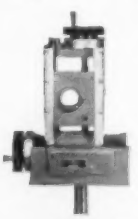
Cut inspection time in half
with new Gaertner
Coordinate Cathetometers

These convenient, reliable optical instruments permit making precise coordinate measurements in a vertical plane. The two dimensions are measured with one setting, object does not have to be rotated. Inspection time is cut in half and resetting errors eliminated.

Versatile Gaertner Coordinate Cathetometers are ideally suited for precision measurements on large objects; also objects or points in recessed, remote, or inaccessible locations. Applications include measuring jet engine sections, complicated castings, printed circuits, bolt holes and bosses on large piece parts, traces on cathode ray tubes, etc.

Because these are optical rather than mechanical measuring instruments, you make non-destructive measurements without contact, distortion, or concern about pressure being applied to the object when making a setting. Instruments available in English or Metric system.

M1236-46— Horizontal range 6", vertical range 4". Reads to 0.0001", working distance 5" to infinity.



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testing. Standards, methods, equipment and some theory are presented in this volume. Theory will be more completely developed in Part 2.

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Among the hardness testing methods described are Brinell, Rockwell, microhardness, Vickers, Scleroscope, scratch, Durometer, file, etc. Geometry, material and manufacture of indentors is analyzed to indicate the effects of indentors. Included also are technical descriptions, pictures and sometimes patent drawings of a great range of hardness testing equipment. Practical information for testing plastics, steels, aluminum, bronze, gears, tubes, sheet, hot materials, cemented carbides and other materials and products is provided.

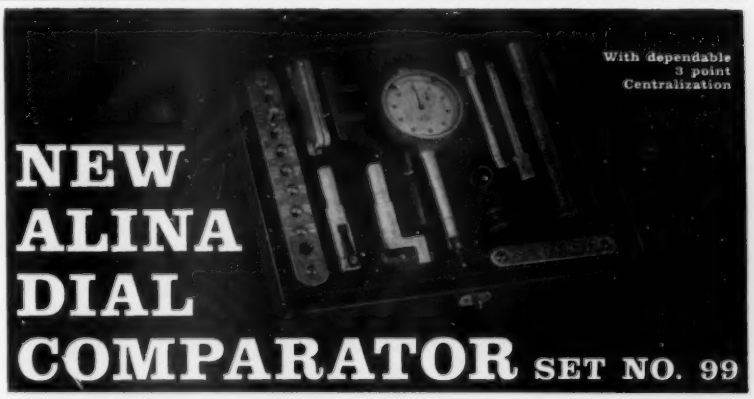
WELDING HANDBOOK, FOURTH EDITION, SECTION THREE—*Prepared under the direction of The Welding Handbook Committee. Published by the American Welding Society, 33 W. 39th St., New York 18, N. Y. Price $9. 512 pages.*

In this, the third section of the handbook, miscellaneous metal-joining and cutting processes are covered. Adhesive bonding and the welding of plastics as well as ultrasonic welding are subjects newly included in the handbook. Other chapters include: forge welding, thermit welding, induction welding, surfacing, metallizing, brazing, soldering, oxygen cutting—auxiliary oxygen cutting processes, arc cutting, welding by cold working and stud welding. The book is adequately illustrated and interspersed with tables.

ENGINEERING MANUAL—*Edited by Robert H. Perry. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y. Price $9.50.*

This compact volume puts together the most commonly used formulas and data in each of several fields of engineering. Three sections are devoted to mathematics, mathematical tables and physical and chemical data. The remaining sections cover fields of architectural, chemical, civil, electrical, mechanical and nuclear engineering.

Theory and description have been omitted and thus the book becomes valuable as a reference only, rather than instructive. Some knowledge of each of the subjects is therefore presupposed and the book is used for quick answers to the more simple problems which can be solved by plug-in formulas.



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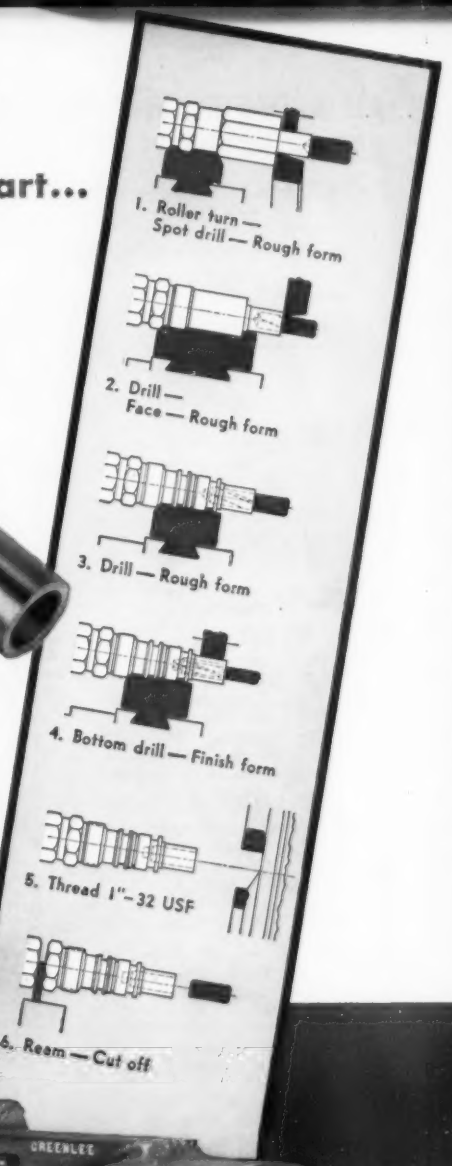
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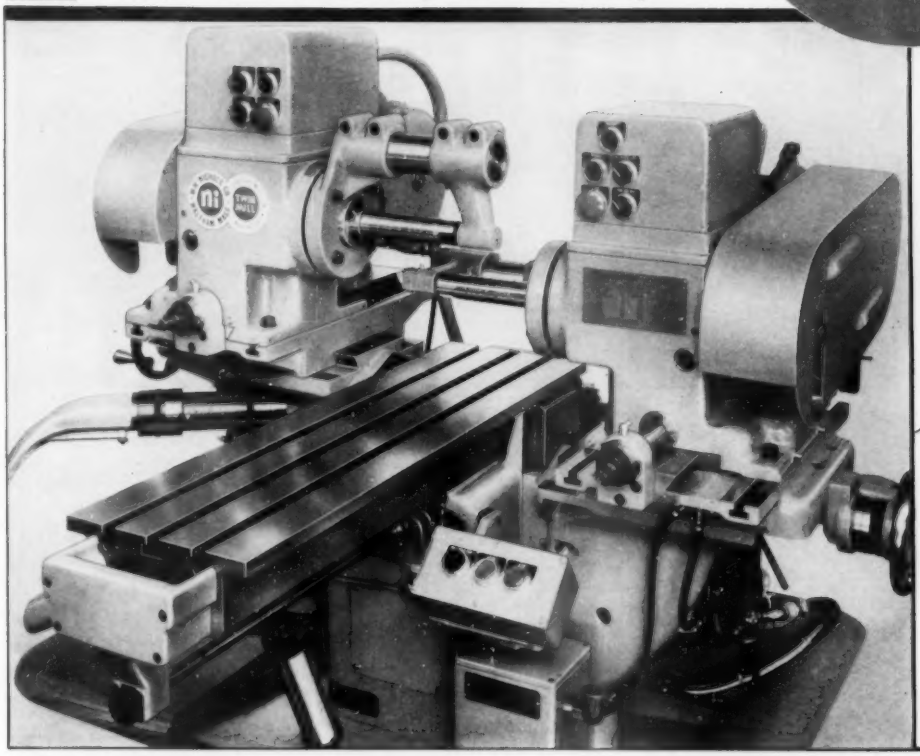

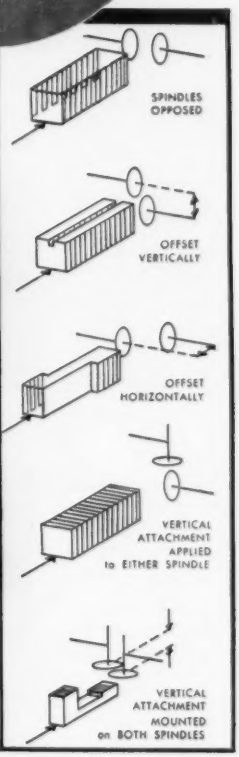

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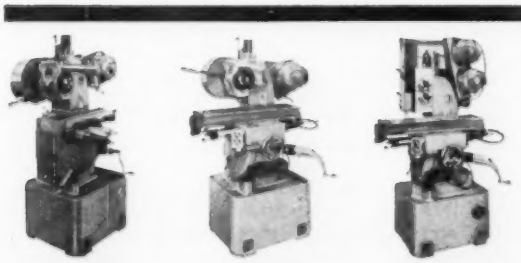

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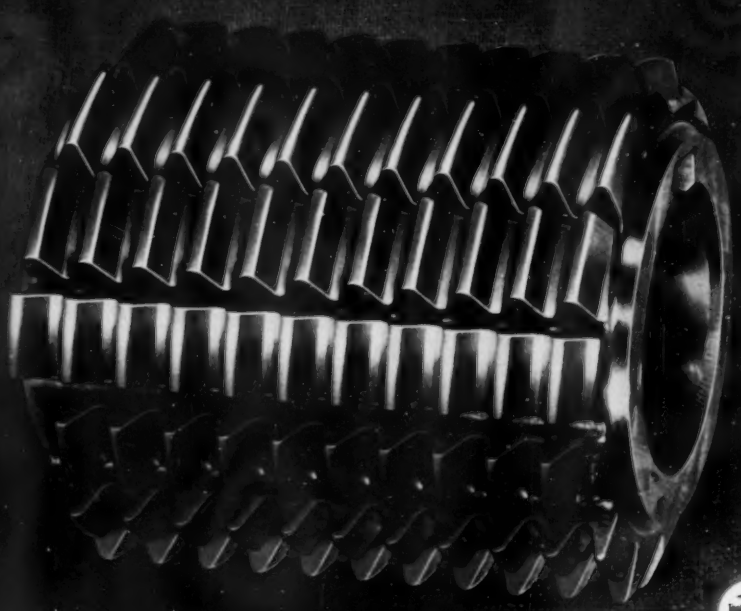

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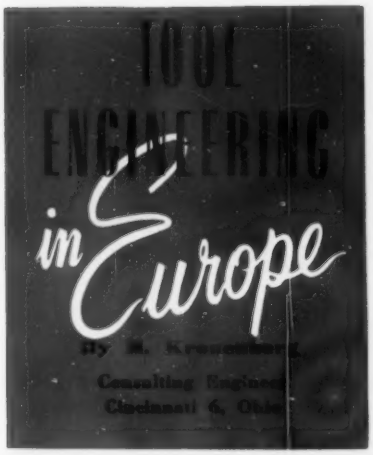

Milling Wood

Several types of forced and self-induced vibrations are found in metal-cutting machine tools. Vibrations in wood-cutting machine tools are usually caused by unbalance, because variations in cutting forces are normally of less importance than in metalcutting. After running tests, A. Bronner has concluded that the large centrifugal forces set up in woodcutting machines are the main reason for vibration. His report is published in *Werkstatts Technik*, April 1960, p. 183 ff, under the title, "Das Schwingungs Verhalten der Holz Frasmaschinen."

Spindle speeds up to 24,000 rpm are now often used, causing vibration of the milling machine table and reducing the friction between the wood and the table. Since the workpiece is often fed by hand into the tool, the operator may lose control under vibration and accidents may result. The accuracy of the workpiece is reduced by vibration as well.

The author discusses the theory of vibration, simplifying the machine to a single mass suspended by a spring and equipped with a dashpot to indicate damping. The differential equation leads (under these assumptions) to the well-known diagram where the magnification of the amplitude is plotted for various damping factors against the ratio of the forcing frequency to the natural frequency.

Critical speeds for the milling arbor are calculated. It is shown that in the case of wood-cutting machines the arbor straightens itself when run above the critical speed. The author does not recommend use of this effect since the machine must be run through the resonant (or critical) speed where accidents could occur.

Natural frequencies of arbors, machine tables, frames, housings and other major machine elements are given. The author recommends increasing the height and arrangement of ribs instead of increasing the wall thickness. Diagonal ribs affect torsional vibrations set up in tables, while longitudinal and transversal ribs affect bending vibrations.

Ball bearings and their effects in producing vibrations are also discussed in the article, as is the increase in amplitude in the case of self-induced vibration. It was found that vibrations can cause the arbor to be deflected by a force 10.8 times as large as the cutting force itself.

Fastener Torque

Manufacturing engineers are often confronted with the problem of determining the torque that is admissible in fastening nuts or screws used to assemble machinery.

A new approach to this problem was taken by R. Kellermann and H. Klein, who investigated the relationship between preload, torque, coefficient of friction and the limit where plastic deformation of the screw would occur. They report on their findings in *Werkstatts-Technik*, Vol. 50, No. 4, 1960, p. 192 ff under the title, "Anzieh Drehmomente fuer Schrauben-Verbindungen."

The article contains numerous diagrams and tables that can be used directly to determine the admissible torque for various types and sizes of screws in metric dimensions. Equations for the relationships are likewise presented by the authors. They introduce the concept of rating the yield strength, assigning the number 1.0 to the value that, if exceeded, will result in failure of the screw. Different safety factors are used for determining the admissible torque.

The thoroughness with which the investigation has been carried out is best illustrated by a problem that can be answered by using the information published in the article: "What torque must be used in the assembly of two parts to be fastened together by a screw of German Standard M10 with galvanized thread (quality class 8g; 0.0003-inch thickness of zinc) when the female thread is bright and no lubricant is used? How much must the torque be reduced if the zinc layer is replaced with a cadmium layer 0.00008 inch thick and what is the change in maximum pressure at the contacting surfaces?"

Detailed answers to these questions can be found in the tables. In the case of the cadmium-coated screw torque must be reduced from 31 ft-lb to 26 ft-lb. The contract pressure increases by 11½ percent.

Friction Losses

Calculation of power losses due to friction has become important in view of the fact that the spindle speeds have considerably increased in recent years.

The conventional method employed for determining the power losses in the gear train is no longer acceptable in the opinion of G. A. Levit, whose article "Calculation of Friction Losses in Machine Tool Drives" appears in the Russian magazine *Stanki i Instrument*. An English translation is found in *Machines and Tooling*, Vol. 30 (1959), No. 9, p. 2 through 11.

The article deals with a method developed by "Enims", the Russian machine tool research institute, where about 2500 engineers are engaged in metalcutting and machine tool investigations. The author takes into consideration power losses due to friction in bearings and gears, losses due to turbulence in lubricating oil, ventilation losses and friction in gear change forks. Graphs included in the article give data on friction losses for various fits, bearing temperature, viscosity of the lubricant, losses in V-belts, number of shafts, gears and other such items. Examples of calculations are also covered in the article.

Clamped-on Lathe Tools

When clamping carbide or ceramic tips to a tool shank, it can often be observed that a small gap exists between the mating surfaces, subjecting the tip to undesirable bending stresses. On the other hand, according to G. M. Rivkin's article in *Stanki i Instrument*, Vol. 30, No. 2, p. 35, when the tip is not clamped at all, but held in place by the cutting force, the tip is subjected only to compression, increasing its performance considerably.

Experiments were carried out in a metalcutting laboratory with various lathe tools to establish the maximum feeds at which a ceramic tip would chip or a crack occur. Details on the tool geometry are included in the articles both for tools that were not entirely satisfactory and for an improved design. A feature of this design is a wedge-shaped lip supporting the bottom of the tip. Under cutting force, the tip is firmly held and pressed against the bottom surface. The tight fit retains the tip in its non-working position. The tip can be removed by tapping.

A rating figure representing the performance of various designs was developed permitting their comparison. The last-mentioned design had a performance rating of 1.33 as against 0.52 for the poorest of the earlier designs.

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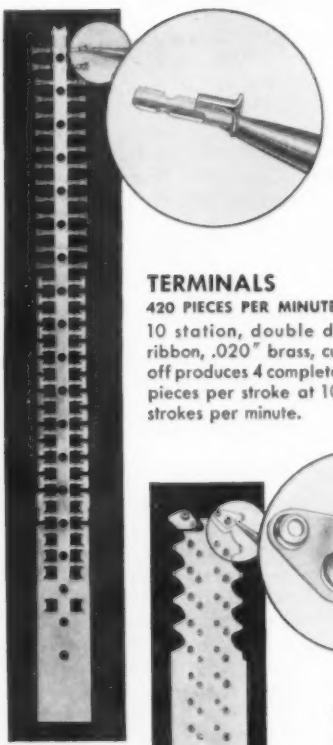

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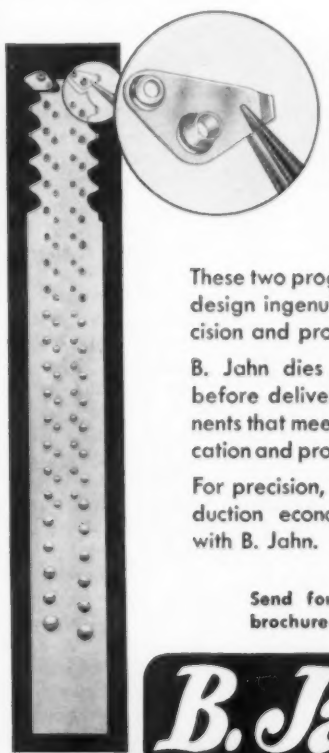

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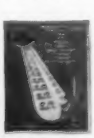

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who's meeting and where

July 7-8. The Pennsylvania State University. Seminar on low-cost automation. Continuing Education Conference Center, University Park, Pa.

July 11-15. Massachusetts Institute of Technology. Summer program, Strain Gages: Fundamentals. M.I.T., Cambridge 39, Mass.

July 11-20. The University of Michigan. Engineering summer conference, Applied Mathematics for Chemical and Metallurgical Engineers. Engineering Bldg., Ann Arbor, Mich.

July 11-22. The University of Michigan. Engineering summer conference, elementary and advanced courses, Semi-Conductors. Engineering Bldg., Ann Arbor, Mich.

July 18-22. Massachusetts Institute of Technology. Summer Program, Strain Gages: Applications. M.I.T., Cambridge 29, Mass.

July 18-29. The University of Michigan. Engineering summer conference, fundamentals and advanced topics courses, Solid State Microwave Amplifiers and Oscillators. Engineering Bldg., Ann Arbor, Mich.

July 22-25. The National Assn. of Metal Finishers. Annual convention. Statler-Hilton Hotel, Los Angeles, Calif.

Aug. 15-17. ASME-AIChE Heat Transfer conference and exhibit. Statler-Hilton Hotel, Buffalo, N. Y.

Aug. 22-26 Massachusetts Institute of Technology. Summer program, Engineering Aspects of the Solidification of Metals. M.I.T., Cambridge 39, Mass.

Aug. 28-Sept. 2. The Pennsylvania State University. Work Measurement seminar. Continuing Education Conference Center, University Park, Pa.

Sept. 6-16. NMTBA. Machine Tool Exposition. International Amphitheatre, Chicago, Ill.

Tech Digests

Characteristics and Performance of Ceramic Tools

The experimental data on ceramic tool life available, although limited in scope, proved of value in application to production tests. Much work remains to be done in evaluating ceramic tool life for other workpiece materials and in explaining the manner of failure in ceramic tools which is different than in carbides. A more consistent or uniform wear process in ceramics may result from further improvement in the material.

Observance of the factors which constitute good machining practice with any tool material, and especially carbides, is even more critical with ceramics in view of their brittle character. Proper holding of ceramic tips is of utmost importance. Adequate rigidity in the tool workpiece—machine complex, freedom from excessive vibration, and sufficient power capacity in the machine tool, of importance in any machining operation, are even more essential with ceramics. Since these materials can be used to greater advantage at speeds higher than customary for carbides, sufficiently high speeds in machine tools must be made available.

It has been demonstrated that for certain turning operations ceramics are the best tool material. Up to now, ceramics have not worked as well in ordinary milling operations as have other tool materials, but it can be anticipated that this situation will be improved with more experience and knowledge.

Ceramics have been used successfully in light milling cuts, finishing cast-iron, steel and aluminum workpieces. Poor performance of ceramic tools has been encountered when machining aluminum alloys of a high-silicon content.

Attention must be focused on reducing the handling or load and idle time which constitutes a major part of the production cost in machining with carbide tools, and with ceramic tools, may account for as much as 90 percent of the production cost of a machining operation. Although much remains to be learned about the technique of machining with ceramics, the potential economic benefits to be derived from use of these materials in many cases is evident, especially in the mass production of machined parts with special or automated equipment of extremely low values of noncutting time. In essence, these economies stem from the greater metal removal rates that are practical with ceramics and from the use of "throwaway" or disposable inserts which are admirably suited to these materials. Such benefits are being realized in an increasing number of instances.

Based on a paper by A. O. Schmidt, Kearney & Trecker Corp., presented at the 24th Annual Machine Tool Electrification Forum, sponsored by the Westinghouse Electric Corp., Pittsburgh, Pa.

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Progress in Industrial Automation

A vital element of the new techniques is systems engineering which is responsible for analyzing the problem, planning the control approach, specifying the required components, and coordinating them into a system to give the performance desired. The beginning of systems engineering tailored drive systems and tools to the user's process and productive requirements. Controlwise, the general technique was to individually regulate quantities such as speed, current, temperature, pressure, etc., so that by keeping all variables constant, the output product would be uniform.

Today, with the new controls, the situation is quite different. Individual feedback units are now only subsystems of a broadened control loop which is putting more and more of the process under the guidance of a master computer controller. This treatment is widening and complicating systems engineering greatly. Of equal importance to control know-how is knowledge of the process and productive machinery to be controlled. For example, the plate mill computer control required several man-months of data gathering and study preparatory to writing the control specification. Furthermore, it takes talented and capable engineers to build a mathematical model of a process and to coordinate individual subsystems into a control which will meet expected performance with the desired degree of safety and stability. The more the control loop is enlarged, the more complex these problems become.

We are in the midst of a decided revolution in the handling of control intelligence and sequencing functions. New families of sophisticated control devices and systems are taking over the control scene. The real meaning behind these complicated controls and systems is that they result in closer "management control" and more uniform output from productive operations.

Based on a paper by W. R. Harris, Westinghouse Electric Corp., presented at the 24th **Annual Machine Tool Electrification Forum**, sponsored by the Westinghouse Electric Corp., Pittsburgh Pa.; April 26 and 27, 1960.

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Explosive Forming

Some of the prime advantages of using high energy forming are: its economics, its ability to hold closer tolerances in the formed components, its ability to minimize the number of pieces required for an end item. It affords a means of fabricating parts out of superalloys which are extremely difficult to form by other means, and it offers a new forming method for aircraft engineers, permitting them to design more intricate parts which were previously impossible to form by conventional means.

A single charge will exert its force downward with an apparent upward wiping action of a sonic wave which creates the forming action. Therefore, cylindrical parts seem to be most adaptable to this process.

This technique also affords a method of forming parts which are practically impossible to form other ways, such as tapered and embossed superalloy airfoil contours where the embossments move during the forming process. Conventional methods of forming this type of material would cause distortion and embossments would be shaved if contacted by a punch.

The impact forming of relatively flat shapes has not proved too advantageous; however, parts in this category have been successfully formed by conventional means, after which they have been sized by explosive forming techniques to yield parts which are of closer tolerance than those obtainable by conventional techniques. This procedure also affords the opportunity of preforming parts by conventional means, heat-treating them and impact resizing them to compensate for heat-treat distortion.

The criteria used for selecting parts that lend themselves to explosive forming are: cylindrical parts for the entire form operation, relatively flat parts that are formed by conventional means and resized to closer tolerances, as well as superalloy parts. Components that do not lend themselves to conventional forming methods, in many instances, can be formed by this technique.

Based on SAE Paper No. T39 by Floyd A. Cox and Ernest F. Mellinger, Ryan Aeronautical Co. Society of Automotive Engineers, Inc., 485 Lexington Ave., New York 17, N. Y.

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Electrical Systems for Electrohydraulic Forming

The basic circuit involved in electrohydraulic forming consists of a rectifier supplying a bank of capacitors through a charging resistor, and a discharge circuit consisting of a switch and a gap in a vessel containing water or other fluid. The metal to be formed and a female die are placed in the vessel. The water must be removed from the space between the metal and the die. In addition, the space must be well vented or evacuated to obtain the proper results. Discharge of the capacitor through the gap in the fluid creates a shock wave which forces the metal against the die.

A switch and resistor are connected across the capacitor bank to discharge the capacitors in case it is not desirable to discharge them through the load. When not in use, high-voltage capacitors are shorted to prevent build-up of voltage which could present a hazard to personnel. A switch may also be needed between the rectifier and the capacitor bank to control the charging cycle. In some cases, this is accomplished by the switching on the a-c side of the rectifier.

The charging circuit usually consists of a rectifier, a resistor, and the capacitor bank. The rectifier is normally single phase, full wave. However, a three-phase rectifier becomes a logical choice for large capacitor banks and fast charging rates. With the simple resistance—capacitance circuit, the charging characteristic is exponential with a time constant equal to the product of the resistance in ohms and the capacitance in farads.

In a single-phase full-wave rectifier, the average voltage of the rectified sine wave is approximately 63 percent of the peak. For a given capacitor bank, the rectifier rating is dependent on the charging time. In determining the charging time, it is important to consider whether the rectifier is rated at average of peak voltage.

For most systems now being considered, the simple resistance-capacitance charging circuit is adequate. As systems grow larger and use in production increases the importance of charging time, more sophisticated charging systems can be justified. These may take the form of multistep charging resistors or constant current schemes to increase the rate of charging at higher voltages to use the rectifier capacity more fully.

Capacitors are the heart of the system and, although they are basically simple devices, there are several characteristics that should be carefully considered in their application. The most important part of a capacitor is the dielectric. In order to reduce the size and cost of a capacitor, it is desirable to use a minimum thickness of dielectric. On the other hand, reliability and life increase with thickness of the dielectric. For production use, where millions of discharges are required, the dielectric of energy storage capacitors may be worked at 1500 volts per mil. For experimental use, where a life expectancy of 5000 to 10,000 discharges is satisfactory, the dielectric may be worked at about 2000 volts per mil. Tests of capacitors using 2180 volts per mil indicate that after 5000 operations, only four percent of the units failed. When specifying capacitors for experimental installations, it is wise to bear in mind that the cost of capacitors per microfarad at 2000 volts per mil is approximately half that at 1500 volts per mil.

Switching for initiating the discharge of the capacitors has been accomplished by gaps and ignitrons. Usually an air gap has been used and the discharge initiated by physically reducing the length of the gap or by ionizing the air in the gap by means of a discharge in an auxiliary gap. It should be recognized that a mechanical switch or contactor used in high-voltage discharge circuits is a gap for all practical purposes since the voltage jumps across the contacts and the discharge is over before the switch is completely closed.

One problem with gaps is the noise during discharge. This is usually not objectionable for experimental work but is objectionable on a production floor, and some way of silencing the gap is required. High-voltage vacuum switches have been used; however, those presently available are limited in current capacity. Ignitron tubes are being used on some large systems. Inexpensive tubes capable of withstanding 20 kv are available and can be used to parallel groups of capacitors by parallel firing, since variations in firing time are small compared to the discharge time of the main circuit. At present, the expected life is 1000 discharges which is adequate for experimental use. Development is proceeding to increase the life of the tubes which will make them more desirable for production use.

Based on a paper by L. W. Herchenroeder, Westinghouse Electric Corp., Pittsburgh, Pa., presented at the 24th Annual Machine Tool Electrification Forum, April 26 and 27, 1960.

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Project Justification and Evaluation

What are the questions covered in a project justification as well as those considered in the final corporate staff review? Let's take the make or buy question. First, we like to know the dollar amount of facilities required. If the engineering economy study looks good, we want to know basic information regarding our competition. Is this a field we should be in? Does it require special skills—if it does, do we have them—if not, how do we get them and what would suffer in the meantime? We have to make a careful study of the current manufacturing capabilities. We realize that a manufacturing manager, if he is a good man, has to have the confidence and belief that he can handle any job. If information indicates he could effect a cost reduction by making an item rather than buying it, he wants to go ahead. Here again is a case where you can't be familiar with

the over-all situation if you are sitting in a chair in the main office—you must get out and get a good understanding of the operation in order to make a proper evaluation of the manufacturing talents available and of the capital facilities actually required to accomplish a given objective.

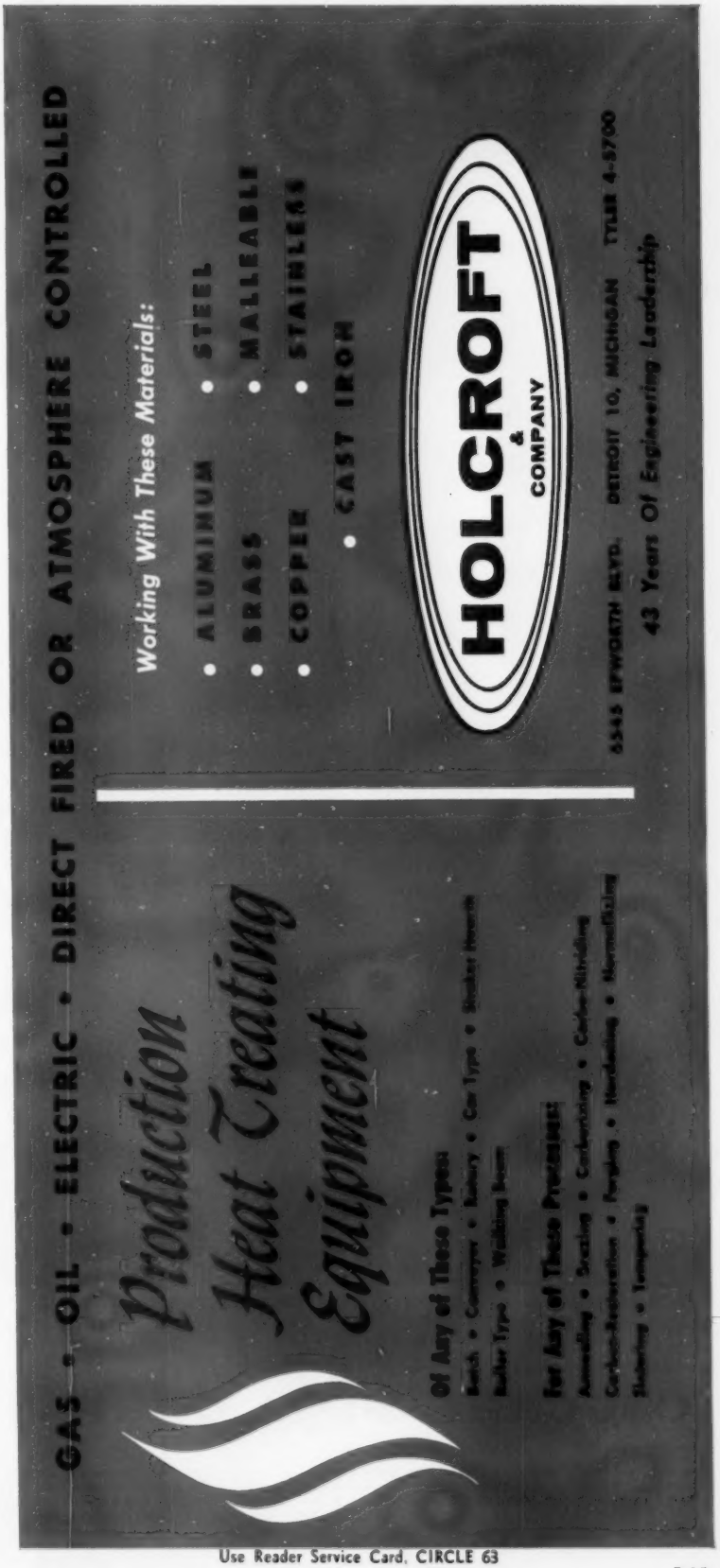
Another basic manufacturing facilities question is should a customer purchase order be obtained or should capacity be developed first? For example, a question regarding a limited number of specialized machines for missiles should involve: What is our position as a subcontractor? Who has facilities for this limited business? What is the Government status regarding furnishing facilities? What might be the future pattern of the Government support regarding facilities? What is the current order situation? How stable is it?

TO REQUEST COMPLETE PAPERS WRITE TO THE ADDRESS AND ORGANIZATION INDICATED AT THE END OF EACH ABSTRACT

What is the profit margin? How long will it take to break even? What this amounts to is really an evaluation of the risk versus other ventures. We expect answers to all of these questions before we consider going ahead with the planning and acquisition of facilities. In many cases, you would say "With all of those questions, how can you ever obtain facilities?" Actual experience reveals that we have obtained the capacity first many times, but we want to be sure we know the full story or as much as is feasible in advance of the major capital decision.

Another basic area that needs review is capital equipment for very competitive areas. We want to know what is the impact, for instance, if we approve a limited pilot line with standard machines. Could we use these machines for other operations? Would this be good judgment? Frequently the old question arises—do you rush in and lose your shirt or do you wait and lose the market? Here, we have to be very familiar with the situation in order to make an evaluation and it is most important to make sure that the operating people have considered all of these phases that may affect their future operation.

Based on SAE Paper No. 155A by Carl W. Goldbeck, Thompson Ramo Wooldridge, Inc., entitled "An Integrated Approach to the Planning, Evaluation, and Control of Capital Facilities." Society of Automotive Engineers, Inc., 485 Lexington Ave., New York 17, N. Y.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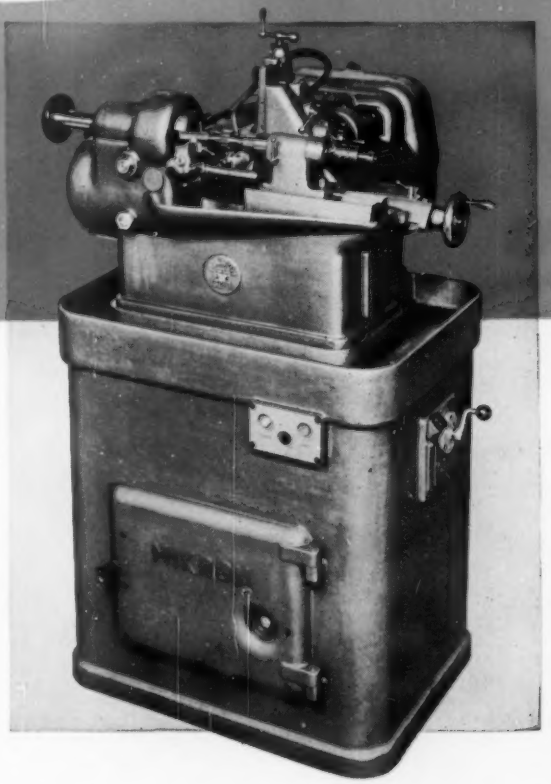

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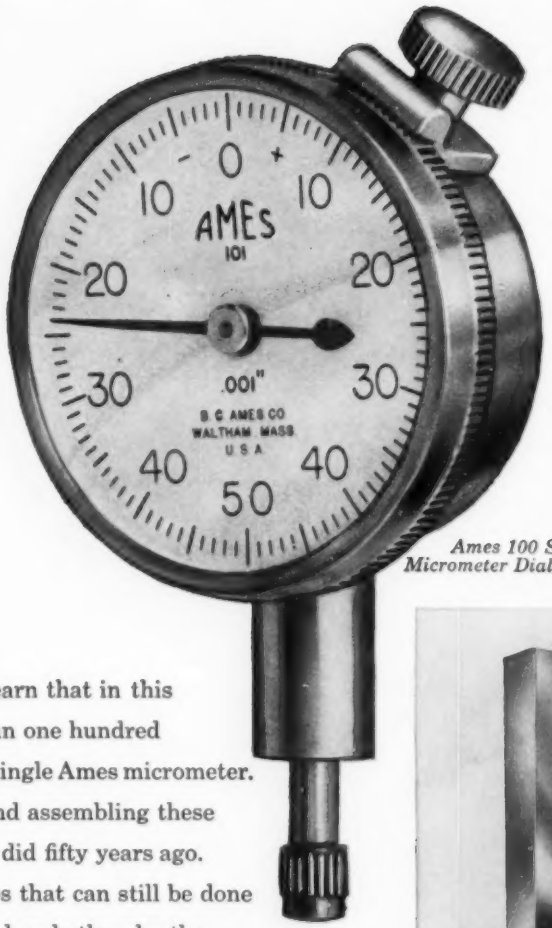

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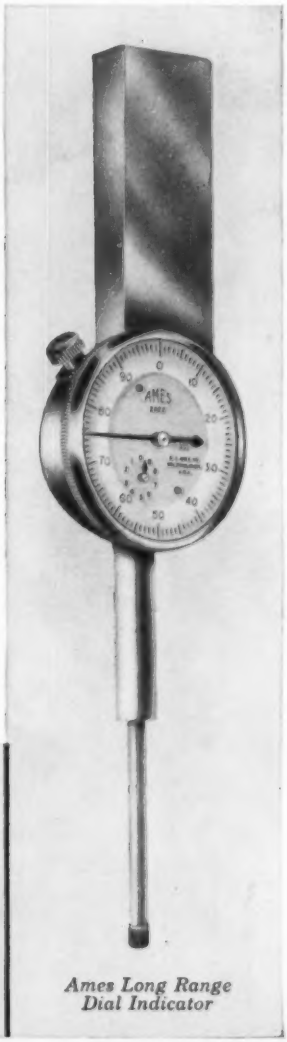

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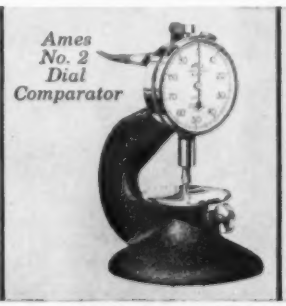

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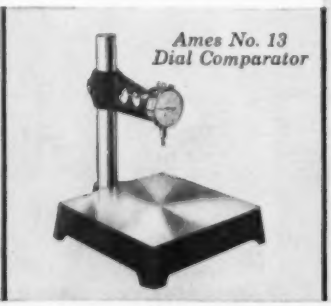

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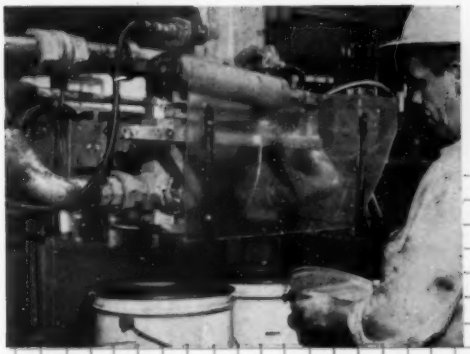

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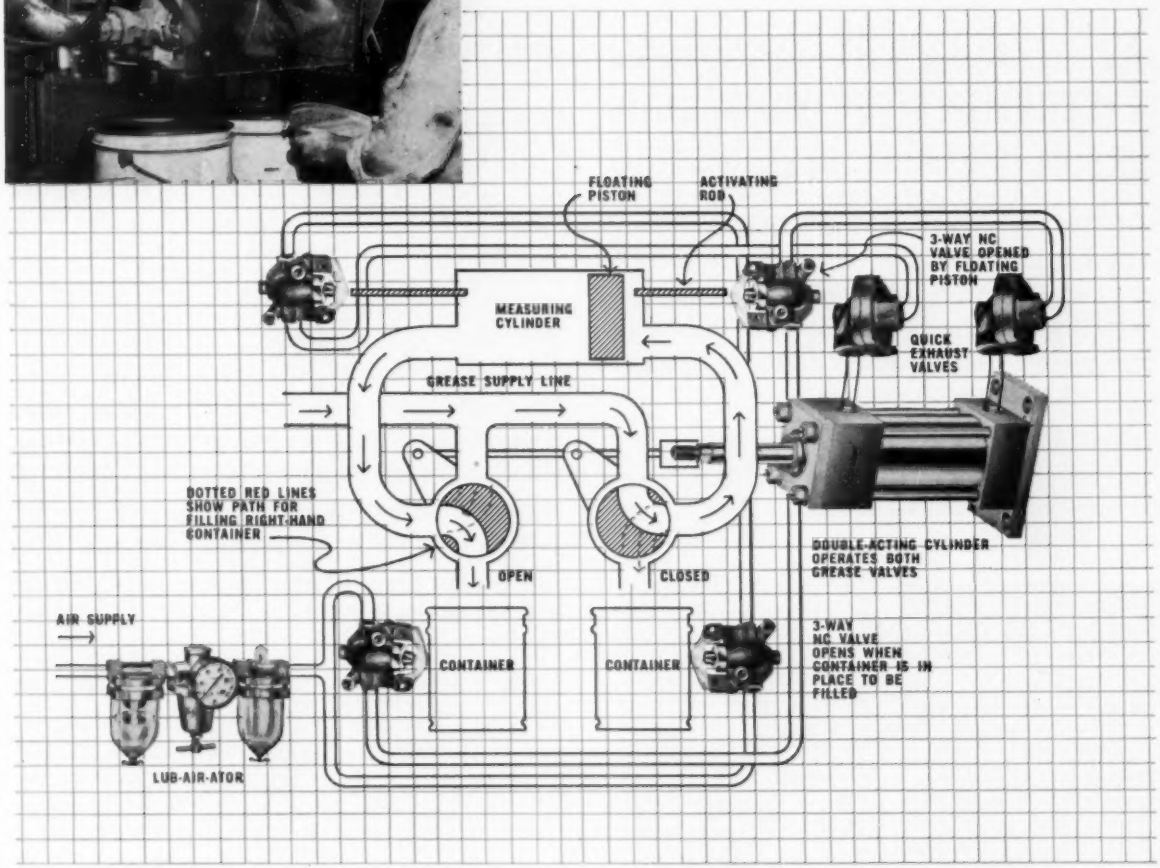

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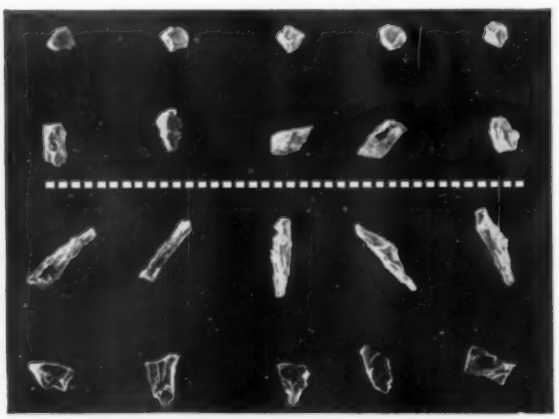
SND — a new natural diamond

SND—THE LATEST TECHNICAL DEVELOPMENT FOR IMPROVING CARBIDE GRINDING PERFORMANCE

SND (Selected Natural Diamonds) is a *New* natural diamond abrasive developed especially for resinoid bond grinding wheels. It is made up of needle shaped grains and thin, flat platelets selected from diamond boart that has been crushed by a special method.

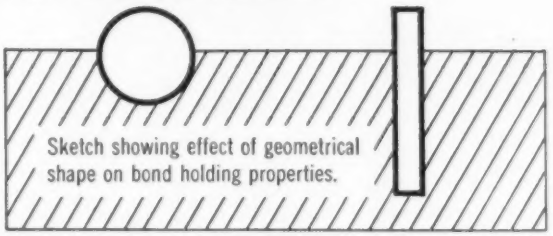
Diamond particles at least twice as long as they are wide are classified as "needles," and particles that are less than one-quarter as thick as they are wide are classified as "platelets."



Top: Blocky diamond particles predominating in conventional grit.

Bottom: Needle and platelet diamond particles predominating in new SND Selected Natural Diamond grit.

Why "needles and platelets"?



Sketch showing effect of geometrical shape on bond holding properties.

For many years, blocky shaped diamond particles were considered ideal for any type bond grinding wheel. Recent laboratory research into the influence of particle shape on grinding efficiency proved that blocky particles were *not* as efficient in resinoid bond wheels as were thin, flat and needle shapes.

Subsequent tests bore out the important facts that, blocky shapes either wore down level with the matrix, or were pulled out of the bond; while needles and flats seldom pulled out, and instead of wearing smooth, tiny bits broke off in a manner which constantly exposed new, sharp cutting diamond edges to the work.

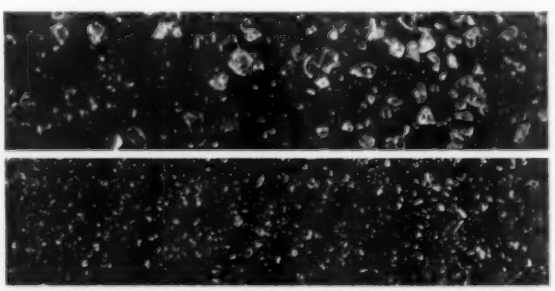
Tests verified by sludge analysis

Analysis of the sludge and swarf collected after tests of both SND and conventional grit wheels verified the test findings. Only uniformly tiny diamond particles were found in residue from SND wheels, proving that each SND particle was almost wholly utilized in the grinding process.

Conventional natural diamond grit sludge ▶

The absence of large particles in SND—Selected Natural Diamonds sludge shows *why* SND gives up to 30% longer wheel life and increased wheel efficiency over conventional diamonds.

SND-Selected Natural Diamond grit sludge ▶



grit for higher grinding efficiency!

How SND (Selected Natural Diamonds) increases grinding efficiency

SND provides more sharp cutting edges per carat in the same grit size.

More cutting edges means a faster, cooler cutting wheel that will last up to one-third longer than resinoid wheels made with conventional grit.

The thin needle and flat grains in SND possess the right amount of natural strength, yet break down easily for fast, free, and continuous cutting.

SND grit offers maximum holding surfaces to the bond, reducing non-productive pull-outs.

SND sharper cutting edges reduce wheel loading and glazing.

Proved in laboratory runs . . .

Extensive laboratory runs show SND grit is up to 30% more efficient than conventional grit when grinding cemented carbide at .0005" to .0015" in-feeds and speeds of 5500 S.F.M.

Proved in the field

Many metalworking plants now are proving the new SND grit in their own shops with results that substantiate the already-completed laboratory evaluations.

TREATED SND—ANOTHER NEW GRIT DEVELOPMENT!

A process for treating SND (Selected Natural Diamonds) grit to make it even more friable and to give it superior bonding properties in resinoid wheels also has been developed. This process introduces surface irregularities in the otherwise smooth planes of the SND particles; these tiny cracks and crevices promote faster breakdown after wear and stronger bonding. Already proved to be more efficient than conventional grit at feeds of .0005" to .0015", on carbide, Treated SND is recommended only for lighter feeds, and where the nature of the work demands rapid grit particle breakdown.

The selection is yours . . .

SND grit—for tough applications.

SND Treated grit—for light feeds and coolest cutting.

Conventional grit—for heavy feeds (.003" and up) and the recommended material for metal or vitrified bond wheels.

Available now

Your diamond wheel supplier can now furnish you with grinding wheels made with the new SND grit—either treated or untreated—ask him about SND today!

Diamond experience

Ready to discuss your diamond problems are Industrial Diamond Division Field Engineers located in key metal-working centers. These are technical men with natural diamond backgrounds and experience. Field offices are in Boston, Chicago, Cleveland, Detroit, Los Angeles, Newark, New York.

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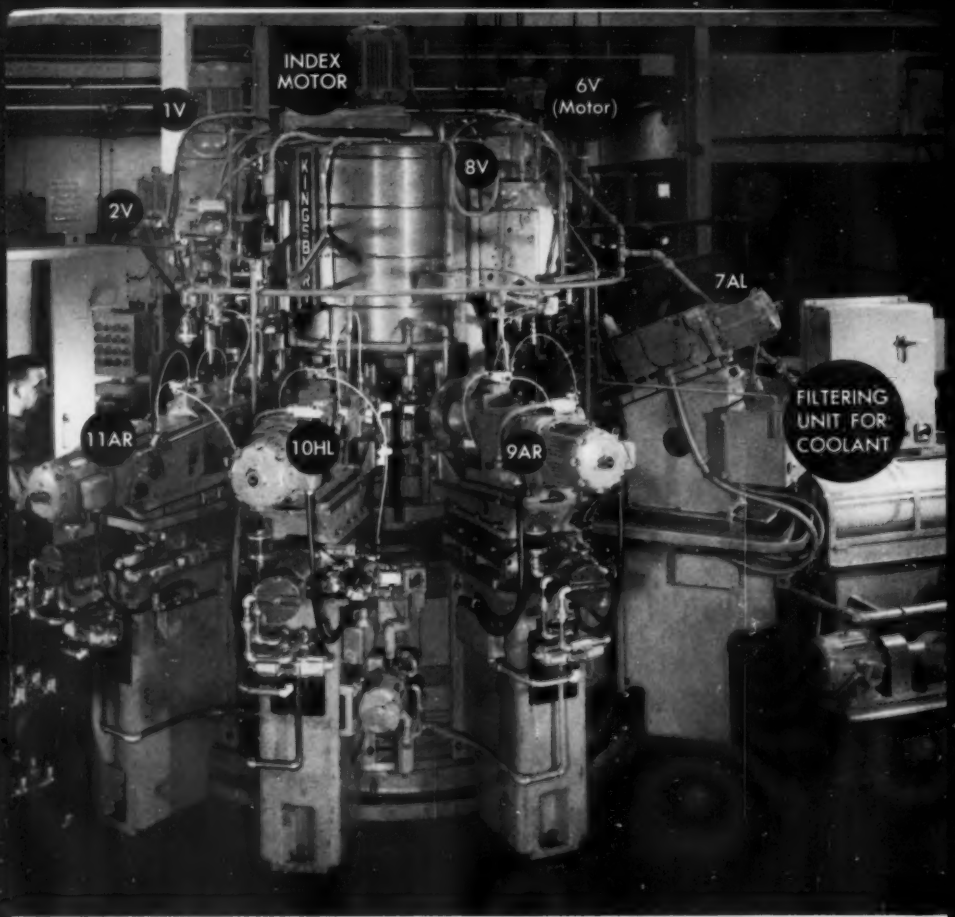

12 OPERATIONS ON GOVERNOR BODY

1V Vertical
Step drill valve hole through

2V Vertical
Mill face 7200 rpm fine finish

3H Horizontal hidden
Rough bore large hole

4AL Angular left, hidden
Drill angular oil hole

5H Horizontal, hidden
Drill flash in 4 holes

6V Vertical
Step gun ream part of valve hole

7 HR Horizontal right, hidden
Drill angular oil hole

7 AL Angular left
Drill angular oil hole

8V Vertical
Step gun ream part of valve hole

9AR Angular right
Mill first oil pocket

10HL Horizontal left
Mill second oil pocket

11AR Angular right
Mill third oil pocket

Kingsbury machine produces fine finish at high rate, performs variety of operations

Easy change-over for work on similar part

In one chucking of the work twelve units on this Kingsbury perform all of the operations shown. With a 19-second time cycle for the operations and indexing, the gross production rate is 190 parts per hour.

SOME NOTEWORTHY FEATURES

Mill face. A motorized spindle produces a fine finish by running at high speed and then retracting from the work on the return stroke.

Mill oil pockets. Airdraulic slides position oscillating heads that feed the cutters sideways inside the hole.

Drill angular oil holes. Each unit is at an angle to the radial center line through its station. Two units are mounted on angular risers.

Five-step valve hole. Two units step gun ream with high speeds and fine feeds using filtered coolant under pressure.

With a few changes this machine also operates on a similar part. A seven spindle auxiliary head can be mounted in two different positions to drill four holes in one part or three in the other.

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If you do drilling type operations in high production — simple or complex — we want to talk business. Our good basic design and accurate rugged construction pay off for you in minimum rejects and downtime. Kingsbury Machine Tool Corp., Keene, New Hampshire.

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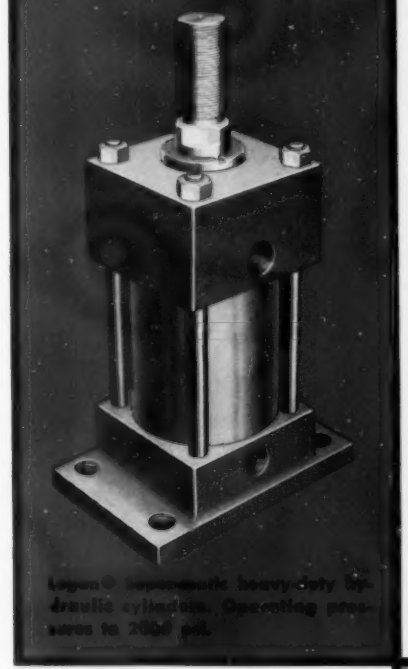

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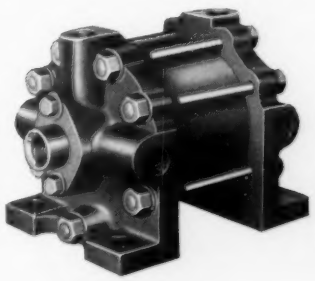

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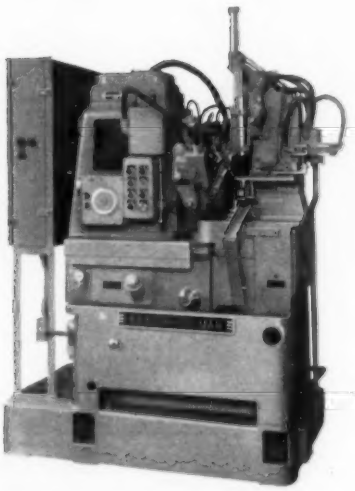


Compact, high-speed hobbing machine combines many advanced principles of gear cutting . . . for manual operation or complete automation

Whether yours is a general-purpose gear shop or an automotive plant requiring high-volume production, Barber-Colman's new No. 4-6 vertical hobbing machine can give you total gear-cutting economy — low tool cost, faster cutting, increased machine utilization.

Here, in a compact vertical, is the perfect combination of high speed, rigidity, versatility, and automaticity . . . carefully built to Barber-Colman's recognized high standards of precision and extra quality.

High capacity in a versatile machine

Automatic cycling of the No. 4-6 includes carriage feed, retraction after the cut, and rapid carriage traverse to the starting position. Combined high speeds and minimum nonproductive time between cuts make decreased cycle times a practical reality. The machine is designed specifically to be tooled for automatic

High Speed, Versatile Hobbing

. . .with Barber-Colman's new No. 4-6 Vertical Hobbing Machine

loading. However, it is simple to set up and can be loaded manually when required.

As an example, the 12-14 pitch, nine-tooth automotive pinions (AISI 1024) shown here are hobbed at 240 per hour at 100% efficiency, using a 3″ diameter x 4″ long triple-thread hob. This job has a feed rate of .045″ per revolution, and a hob speed of 362 rpm (284 sfm). Total cycle time for each load of two pinions is 30 seconds.

The machine is automatically loaded . . . a shuttle places the blanks, two at a time, under the hydraulically actuated tailstock where they are locked in position against the serrated driver. After the cut, the shuttle unloads the finished work and picks up the next set of blanks.

The automatic hob-shifter is an integral part of the automatic cycle. It can be set to operate after each cycle, or after a certain number of gears has been cut. This assures high gear production and low hob cost.

Rugged design increases productivity

Vertical design of the No. 4-6—with integral bed, spindle housing, and upright—provides extra rigidity and simplifies application of automatic tooling. The heavy vertical column rigidly supports all motions of the machine. Movements of the column in both directions are controlled by positive stops. Hydraulic pressure holds it firmly against a depth stop during the cut.

Close-couple design, with short shafts having high diameter-to-length ratios, minimizes vibration, even under the toughest conditions. Both the hob spindle and work spindle are mounted in precision tapered roller bearings.

These are reasons why the No. 4-6 can offer you maximum hob speed of 614 rpm and maximum feed of .150″ per work revolution.

For complete information on how you can gain total gear-cutting economy, contact your Barber-Colman representative or write the factory direct.

MODERN MACHINE TOOLS MMT=PE PRODUCTION EFFICIENCY

See the new No. 4-6 vertical hobbing machine at the 1960 Machine Tool Exposition . . . Booth 923.

Barber-Colman Company

BARBER COLMAN ®

73 Loomis Street, Rockford, Ill.

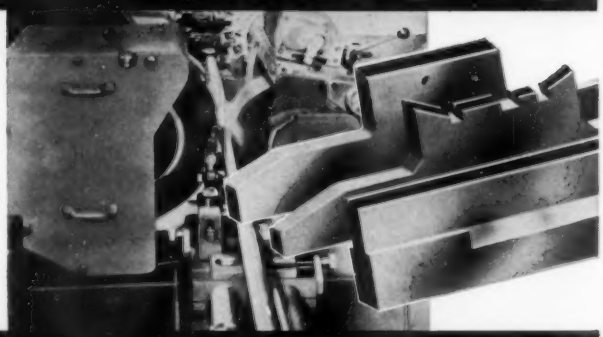
Use Reader Service Card, CIRCLE 73

. . . THREE TALIDE CASE HISTORIES

Talide® BLADES for centerless grinding

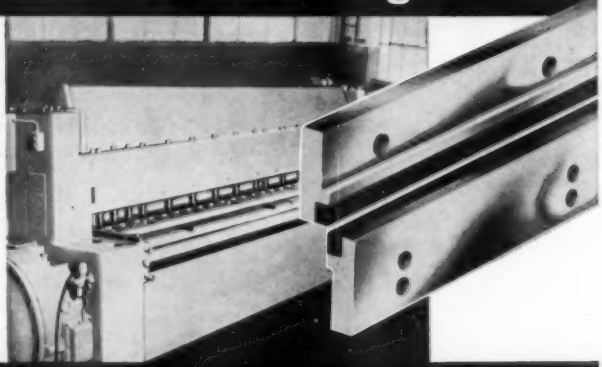
25 YEARS OF TOP PERFORMANCE

using Talide-tipped work support blades on Landis, Cincinnati and Van Norman centerless grinders. Available in lengths up to 120". Tipped with a ONE-PIECE carbide wear strip. No section or seam marks to score or scratch the work. Users prefer blades of Talide superior construction. Over 50 sizes and styles of standard blades are carried in stock. Special blades made promptly to order.



Talide® BLADES for shearing

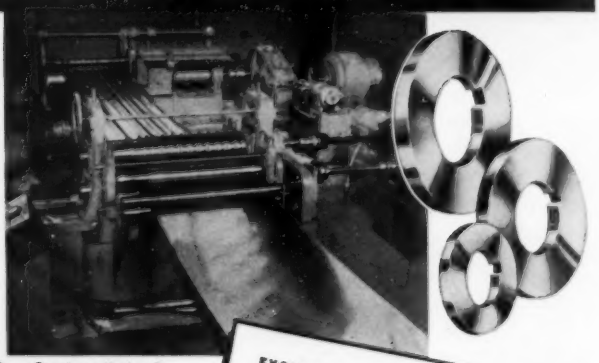
5,631,000 CUTS WITH 59" LONG TALIDE SHEAR BLADES on a Keystone Shear at Westinghouse Electric cutting 29 gauge silicon steel up to 36" wide. 8 months' service life between regrinds saved $2,000 in grinding and set-up time. During this same period it was previously necessary to grind high-carbon, high-chrome blades 24 times — and make frequent replacement. Talide blades normally stay on the job for several years giving high-speed, continuous, burr-free production.



Talide® BLADES for slitting

TALIDE ROTARY KNIVES GIVE PHENOMENAL RUN OF 90 - 1 . . .

A leading strip steel producer of razor blade, high-carbon, spring and stainless steel reports over 1200 coils were gang slitted with Talide knives, compared to 15 coils with steel knives. More tonnage was produced in one regrind of the Talide knives than over the entire life of a set of steel knives. Burr-free, clean-cut edges produced with scrap rate practically eliminated.



Courtesy: Yoder Co.

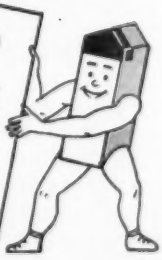
Write for Catalog 59-G Today!

METAL CARBIDES CORPORATION
MC TALIDE®
YOUNGSTOWN 12, OHIO

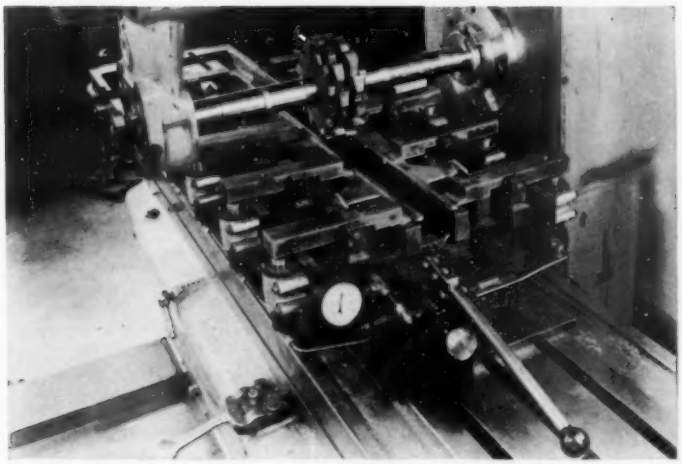
HOT PRESSED AND SINTERED CARBIDES • VACUUM METALS
HEAVY METAL • ALUMINUM OXIDE • HI-TEMP. ALLOYS
OVER 25 YEARS' EXPERIENCE IN TUNGSTEN CARBIDE METALLURGY

EXCLUSIVE RETIPPING SERVICE

Because of its exclusive hot press method, Metal Carbides is able to re-work worn, chipped-out or broken areas of carbide-tipped blades back to original size and dimension with all breaks and defects eliminated.

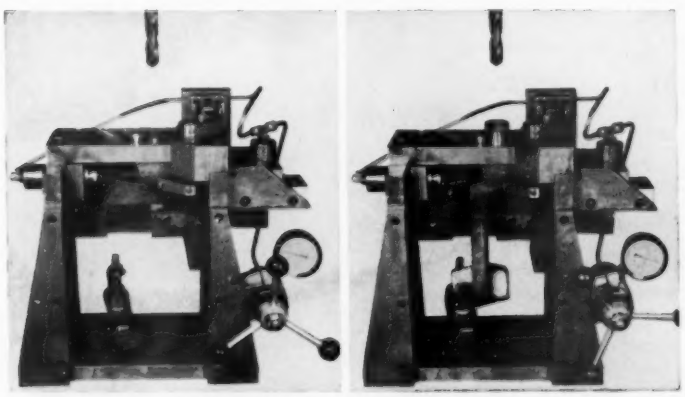


How other shops clamp down on loading time...



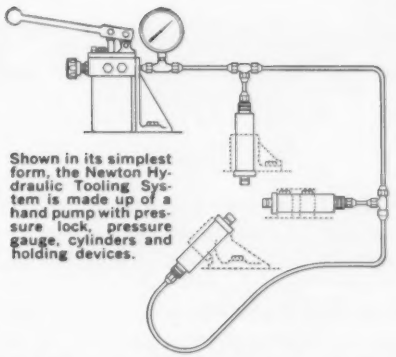
TRIANGLE PACKAGE BOOSTS PRODUCTION 335% . . .
reports Michael Zolnierczyk, Triangle Tooling Supervisor. Former floor-to-floor time, using mechanical clamping, averaged 57 minutes per piece or over 142 hours per 75 pairs. With Newton Hydraulic System, average floor-to-floor time has been cut to 17 minutes per piece, or 42 hours per 75 pairs, including set-up time. "The above figures," states Mr. Zolnierczyk, "represent a saving of 40 minutes per piece part, which is a production gain of 335%." Photo above shows Newton Hydraulic Tooling System installation machining fragile guide rails for conveyor system of meat packaging machine.

(The Triangle Package Machinery Company, Chicago, Illinois, manufactures filling, packaging and wrapping machines of particular importance to the food industry.)



R & H MACHINE SERVICE CLAMPS ODD-SHAPED PARTS RAPIDLY . . .
according to Robert Miller, Chief Engineer, who says: "The new Newton Hydraulic Clamping System is readily applied to a drilling jig for an odd-shaped casting, which would be awkward to clamp by other methods. Shown above are views before and after the part is positioned for drilling." Adds Mr. Miller, "Clamping and unclamping are far more rapid than would be possible with manual clamps. Pressure is uniform regardless of small variations in the size of castings or parts. Economy is another advantage. All the units, with the possible exception of some of the piping, can be used over again on other jigs and fixtures."

(R & H Machine Service, Cincinnati, Ohio are special machinery and tool builders.)



Shown in its simplest form, the Newton Hydraulic Tooling System is made up of a hand pump with pressure lock, pressure gauge, cylinders and holding devices.

Newton Hydraulic Clamping can speed up your production, too . . . . .

Newton System permits rapid operation of clamps in jigs and fixtures in a matter of seconds compared with the minutes lost by mechanical clamping. System consists of actuating pump feeding a number of clamping cylinders with hydraulic fluid under pressure. Extremely versatile, any number of cylinders usable up to pump's capacity. Various clamping positions facilitated. Pre-determined line pressures up to 2500 psi, are rigidly controlled. System provides easy, safe operation in confined work areas. Entirely self-contained unit. Screw or lever pumps, equipped with pressure locks, available in 2 sizes. Cylinders in varied size ranges. Hydropneumatic intensifiers also available for utmost clamping speed.

HYDRAULIC SYSTEM ASSURES:

- **Maximum reduction in clamping time**
- **Multiplicity of clamping positions**
- **Fast clamping of odd-shaped parts**
- **Controlled clamping pressures**
- **Decidedly safe, economical operation**
- **Movable self-contained units — independent of outside power**
- **Wide range of pumps, cylinders, and mounting devices**

A Newton engineer will be pleased to show you the efficiency and economy found in hydraulic clamping. Simply fill out and mail the coupon below.

NEWTON
HYDRAULIC TOOLING CO., INC.
AUBURN, MASSACHUSETTS

NEWTON HYDRAULIC TOOLING CO., INC., AUBURN, MASS.
I would like more information about Newton Systems.
☐ Send literature ☐ Send representative
NAME & TITLE:_____
COMPANY:_____
ADDRESS:_____
CITY:_____ STATE:_____

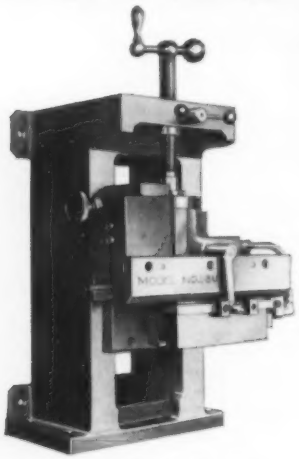
Engineered Marking by CADILLAC . . . *cuts costs*

CADILLAC Builds the Most Complete Line of STANDARD HYDRAULIC and PNEUMATIC MARKING MACHINES

CADILLAC leadership has been established through the development of sound engineering and efficient low-cost marking machine operation and maintenance.

Through simplicity of design, CADILLAC Marking Machines are available in price ranges that meet the demands of cost-conscious buyers.

Shown here are four of the Standard CADILLAC Marking Machines. Highly efficient, they can be installed in your automatic or automated production setup . . . assure permanent product marking. CADILLAC also designs and builds Special Marking Machines, tooling and fixtures, to meet every conceivable marking requirement.



Write for Bulletin No. 58U.

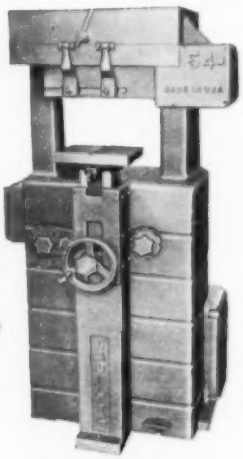
CADILLAC NO. 58U HYDRAULIC MARKING UNIT

Meets the needs of automatic and automated production processes for a standard marking unit—can be mounted in any position—upside down . . . sideways . . . or at any angle. The only completely hydraulic marking unit, employing the roll marking principle, that permits the marking of parts while in a fixtured position.

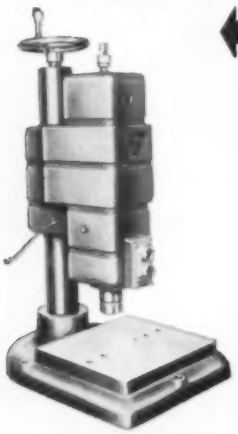
Also available with our standard base and complete with built-in oil reservoir, oil filter, motor and pump system pressure regulator, foot actuator, and all electrical controls.

CADILLAC NO. 54 HYDRAULIC MARKING MACHINE

Here single pressure control regulates full range of pressures—marks round, flat and irregular surfaces. Can mark a very light legend into nonferrous metals . . . extremely deep legends into tough steels. It is ruggedly built and simple to operate.



Write for Bulletin No. 54.



Write for Bulletin No. 52.

CADILLAC NO. 52 AIR IMPACT PRESS

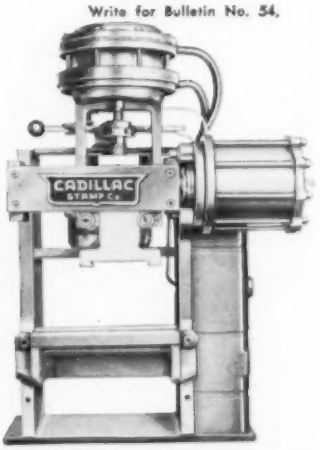
Can be furnished in bench or floor style models. Has built-in features, including positive air and electric safety controls. Highly versatile for—

MARKING	•	BRANDING
STAKING	•	CRIMPING
PIERCING	•	CUT-OFF

COLOR MARKING

CADILLAC NO. 60-U PNEUMATIC MARKING MACHINE

Meeting the needs for a low-cost, power operated roll marking machine, it offers high speed production, low initial cost, and completely automatic work cycle. Can be easily operated in conjunction with a rotary feed table or in an automated line . . . can be mounted in any position desired. Also available with CADILLAC standard base.



Write for Bulletin No. 60.

STAMAX ROLL DIES

Developed by Cadillac for the REALLY tough marking job.

HAND HOLDER INTERCHANGEABLE STAMAX TYPE INSERTS

For marking part and detail numbers, dates, inspection marks, tool checks, name plates, etc.

CADILLAC MODEL NO. 32

Automatic Numbering Head (Special Barrel Style Shown)

Perfect for consecutive serial numbering.

Standard Models Available

SPECIAL STAMAX CODE INSPECTION STAMPS AND SYMBOLS

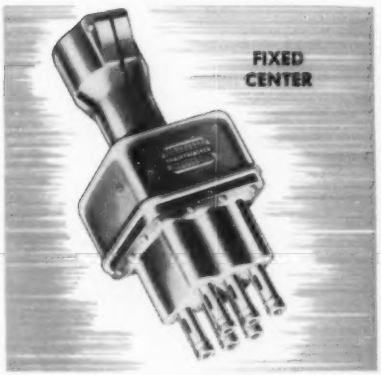
Hard and tough — won't mushroom, chip or split. Priced right.

For further information regarding marking devices and equipment, write for Bulletin No. 41.

CADILLAC STAMP CO. Originators of STAMAX Steel Stamps and STAMAX Marking Dies
Corner of RYAN and NANCY • DETROIT 12, MICHIGAN

RUGGED to full tool capacity!

...FOR LONG WORKING LIFE
TO ELIMINATE DOWNTIME & PRODUCTION LOSSES!



THOMSON
THRIFTMASTER
DRILLHEADS

DRILL • TAP
REAM • BORE
COUNTER-BORE
COUNTER-SINK
FACE

Tremendous economies from the use of multiple-spindle drillheads are obvious. Use *THOMSON* THRIFTMASTER Drillheads for optimum performance and profits. *Ask NOW for our new catalog.*

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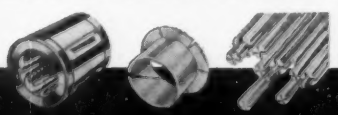
Also Makers of DORMAN AUTOMATIC REVERSE TAPPERS

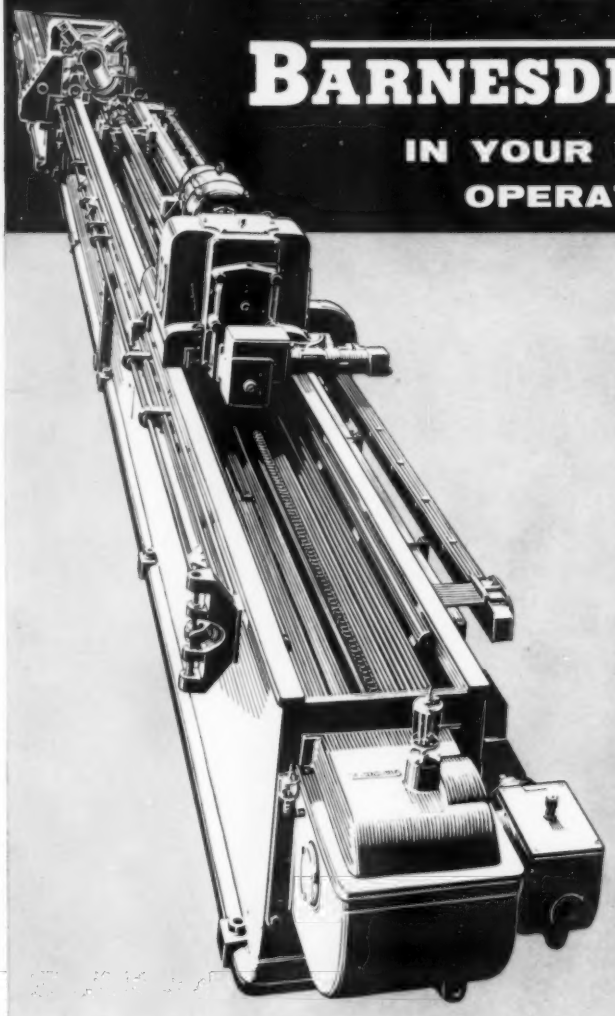


Subsidiary of
THOMSON INDUSTRIES, INC.
makers of BALL BUSHINGS • NYLINERS • 60 Case Shafting

CONSIDER THE ADVANTAGES OF

BARNESDRIL HONING

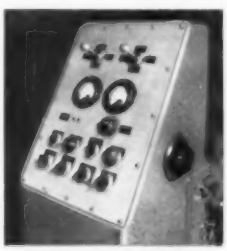
IN YOUR MACHINING OPERATIONS . . .



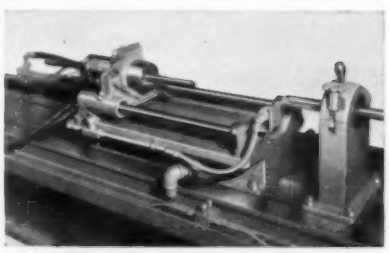
● Fast, accurate, economical metal removal to tolerances measured in tenths of thousandths . . . uniform finishes from 1 to 100 RMS . . . at production speeds. BarnesdriL Honing Machines combine the advantages of geometric accuracy — axial straightness, diametric roundness, and diametric straightness — with metal removal rates comparable to grinding operations. Compensation for stone wear, rapid tool expansion, hone feed, and tool collapse have been integrated as part of the machine function . . . all blended into smooth, fast-reversal stroking by BarnesdriL's exactingly engineered hydraulic drive system.

BarnesdriL Horizontal Honing machines range in size from Model No. 1 with capacity to 11′ length to Model No. 36 for lengths up to 90′. Large capacities and fast metal removal rates make these machines ideal for honing commercial tubing. An additional BarnesdriL feature . . . short stroking at any point in the bore . . . insures a uniform bore size. Electric hone expansion provides continuous control of pressure and automatically compensates for stone wear.

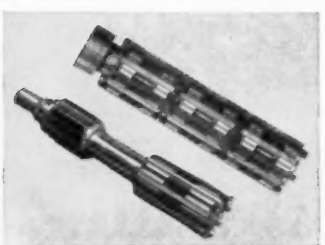
For fast, accurate metal removal . . . consider honing. And, by all means, consider BarnesdriL. We offer a complete line of Vertical and Horizontal machines in a wide range of sizes for internal or external honing. *Write for catalog No. 550 TODAY!*



Speed range and hone expansion can be adjusted electrically in seconds without leaving this conveniently located control panel.



Plugmatic gauging mechanism, a BarnesdriL exclusive, gives positive, automatic sizing from bore to bore on production work.



BarnesdriL engineers can select from a complete line of tools and abrasives to exactly suit your particular honing requirements.

BARNESDRIL

HONING MACHINES

Honing Machines / Production Units / Filtration Units / Drilling Machines

BARNES DRILL CO.

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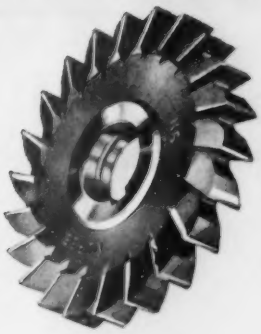
MORSE DISTRIBUTORS GIVE YOU "ALL THE MOSTS"

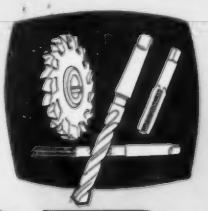


Only Morse-Franchised Distributors have
The Combination That Counts in cutting tools—line, quality, same-day delivery, technical help, finest research backup!

Whenever you have a cutting tool need—whatever tool problems you encounter—the *first* man to contact is your local Morse-Franchised Distributor. He's the man with "*all* The Mosts" in the cutting tool field—he serves you fastest with the best!

In fact, right now his local stocks are so extensive you can phone him, order the popular Morse tools you need, get them *in hours*. Try it—call your Morse-Franchised Distributor now!

Morse means more production . . . smoother, more accurate production...with every type of cutting tool from drills, reamers, taps and dies, to end mills, milling cutters, slitting saws and "specials". So, if you want the best from every cutting tool you buy, mark your order "MORSE". For if you want *Morse Quality*, there's only one way to get it...*specify Morse.*



MORSE

means "THE MOST" *in Cutting Tools*

MORSE TWIST DRILL & MACHINE CO., NEW BEDFORD, MASSACHUSETTS

Warehouses in: NEW YORK • CHICAGO • DETROIT • DALLAS • SAN FRANCISCO

A Division of VAN NORMAN INDUSTRIES, INC. VN

CARL ZEISS

NEW Vertical Metroscope

(BASED ON ABBE'S COMPARATOR PRINCIPLE)

Made in West Germany

Precision Thickness Meter

●

A new mechanical-optical measuring instrument in a form best suited to modern technical requirements. Measurements can be made on the external dimensions of parts with parallel surfaces, cylindrical parts, balls or pieces with spherical surfaces, and threads (pitch diameter by the 3-wire method).

Operator is seated, and his hands do not touch the instrument while measuring—thus it is not subjected to body heat which might affect precise measurements.

Raising or lowering of the measuring spindle and adjustment of reading devices is done by motor drives which are actuated by levers on the right-hand side of the base. Spindle has a 4″ glass scale, the image of which is projected into a 1¾ x 3¼″ window at a magnification of 46x. Easy visibility permits fatigue-free measuring over long periods.

The instrument has a heavy cast base with column for the Abbe measuring unit. Measuring table is 6 1/16 x 5⅛″ and has two working surfaces. One side is grooved for general measuring while the other side has three ribs for gauge-block measurements. Auxiliary tables may be screwed onto the groove side for measuring balls, sheet metal, foil, turned parts with shoulders, etc., and for thread measurements.

Height of measuring unit is adjustable and while in its upper position affords a total working range of 8″.

Write for booklet

CARL ZEISS, INC.
485 FIFTH AVENUE, NEW YORK 17, N. Y.

COMPLETE SERVICE FACILITIES

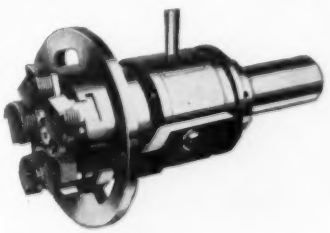
Namco Collapsible Tap Passes Tough Test at TOWMOTOR...

"NO SPOILAGE PERMITTED"

Because I.D. honing and other costly machining precedes internal tapping of outer jackets for hydraulic cylinders, Towmotor Corporation specified a Namco RST Collapsible Tap to insure "no spoilage" tapping. Supplied with a 5-chaser circular head and installed on existing turning equipment, the tap cuts perfect Class 2 threads . . . *on every piece;* meets Towmotor's rigid requirements with ease.

Namco Collapsible Taps can be used for long or short runs and on rotating or stationary spindle machines. Long life circular chasers can be ground to micrometer settings with cost-cutting consistency. They're adjustable to all diameters with a full range of sizes to meet your most demanding applications . . . 1¾" to 7½"; 5" to 15½".

Write for complete details on how Namco Collapsible Taps boost profits through better tapping.



National Acme

THE NATIONAL ACME COMPANY
193 E. 131st STREET
CLEVELAND 8, OHIO

Sales Offices: Newark 2, N. J., Chicago 6, Ill., Detroit 27, Mich.

Precision Ground

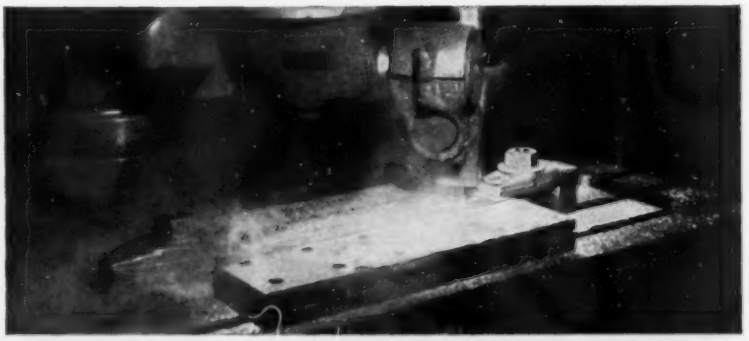
Atrax SOLID CARBIDE TOOLS AND BURS

Job Applications

New cutting efficiency has been designed and engineered into a new line of Atrax Stub Routers. These are solid carbide standard, off - the - shelf tools available in nine sizes from 1/16" to ½" diameter and 1" to 1½" in length.

Precision ground, the Series 1546 Router has a single, straight flute, straight shank and right hand cut. Tolerances are kept to +.000 −.003.

NEW ATRAX STUB ROUTER PLUNGES, SLOTS, FORMS EXTREMELY HARD-TO-CUT MATERIALS

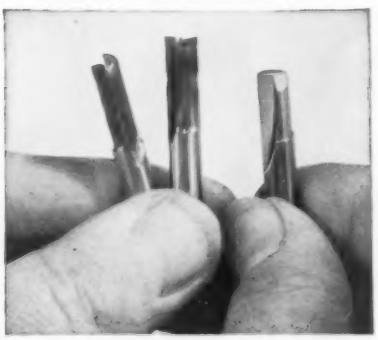


SHOP TESTS PROVE SUPERIORITY

This photo shows the second of two high speed steel routers failing to cut copper clad Fiberglas printed circuit board. Note the burning of tool and material and the jagged hole at left in test work piece.

The new Atrax Router plunged and cut at 20,000 rpm leaving clean slot shown at right.

COMPARISON OF TEST TOOLS



Two high speed routers on left were unserviceable after a few seconds. Atrax Solid Carbide Router showed no wear land and left clean slot with no bur on either side of printed circuit board.

ADDITIONAL TESTS ON OTHER TOUGH MATERIALS

Nine other materials commonly used in printed circuit board work were tested. All were cut quickly and efficiently with the new Atrax Router.

These materials can also be drilled readily with the new Atrax Micro-Drills available in wire sizes from #1 to#80.

SOLID CARBIDE TOOLING RESULTS

in savings in production time and in experimental prototype circuit board work. Many of the new extremely tough materials can be worked faster, easier with Atrax Routers, Drills and End Mills. The Atrax Company will be pleased to furnish information on speeds and feeds recommended for best results.

Send for 148 Page "Standard Reference" on Solid Carbide Tools.

THE ATRAX COMPANY
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- train production men
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This is "Abrasive Tech" the Product Engineering Department of Behr-Manning Co.; inside are assembled the most modern production equipment and prototypes of the newest machines for every phase of coated abrasive grinding and polishing of every known material.

Inside are "Abrasive Tech" specialists — engineering and production experts whose job is to devote their time, skill and energies to helping you solve your problems. And they know their business. There are also Behr-Manning Machinery Methods Rooms in 16 conveniently located branches to help you in exactly the same way. Write for a detailed brochure of "Abrasive Tech" Product Engineering facilities and a list of the machinery at your service. Dept. TE-7, BEHR-MANNING Co., Troy, N. Y., a Division of Norton Company.

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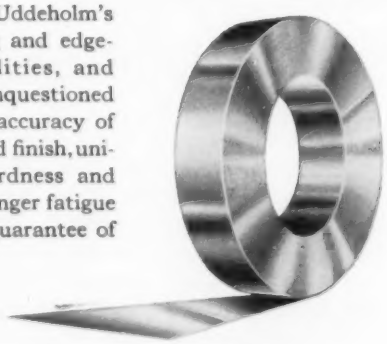
Can Supply your Specialty Spring Steel Needs...

From Stock!

THICK to .125"	THIN to .001"	**WIDE** to 16-1/4"	NARROW to 1/8"

When you need spring steels of the highest quality—and you need them *now*—call your nearest Uddeholm Specialty Spring Steel Service Center. A hard-to-find tempered size, such as .016" x 12½", in polished blue is always in good supply as well as other unusual sizes and types. A full size range of annealed SAE 1075, 1095 is also available. In fact, you have more than a thousand sizes from which to choose in various tempers, finishes and analyses. And at every Uddeholm Specialty Steel Center—Newington, Connecticut, New York City, Cleveland, and Los Angeles—you will find trained personnel to help you select precisely the right type of steel for your needs.

Furthermore, Uddeholm's modern slitting and edge-finishing facilities, and Uddeholm's unquestioned reputation for accuracy of size, flatness and finish, uniformity of hardness and analysis, and longer fatigue life, are your guarantee of satisfaction.



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America's finest automatic transfer machines made by a light bulb manufacturer!

Many years ago we discovered that Sylvania specifications for automation equipment were so exacting, we had to make the machines ourselves. Nothing accurate enough was available anywhere, at any price.

For 20 years we have been making this automation machinery to produce our own light bulbs, radio tubes, fine electronics equipment. No one has ever equaled Sylvania automation machinery for accuracy and long-term dependability.

Now these machines are available to outside companies seeking this same extraordinary degree of accuracy.

Ideal for high-speed automatic fabricating, finishing, assembling, indexing, packaging, these machines are available in two general types:

1. Conveyor indexing chassis, exceptional for the extreme accuracy, strength, and versatility of its chain—not made commercially, but by Sylvania itself. Chassis also provides greater tool and driving capacity than other such chassis on the market.

2. Rotary indexing chassis in two sizes and in single and double turret models. Made with unusually great driving and tool capacity. Top of the transmission spider is specially machined for rotary vacuum or pressure valve.

Also, precision indexing transmissions (5 models)

- **Heavy-duty unit** with extra-large cam well and spider diameter for wider range of stops per revolution.
- **Standard unit** features higher cam speeds, a provision to integrally mount rotary vacuum or pressure valves.
- **Universal unit** operates with its output shaft horizontal or vertical. Has wide range of applications.
- **Small universal unit.** Lower silhouette and extra-long input shaft are main features of this extremely durable, accurate transmission.
- **Conveyor unit.** Very rugged, heavy-duty unit designed for conveyors, but easily adaptable for rotary tables, other intermittent motion machines.

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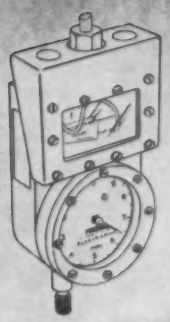
Lights show size category. Actual work size is shown on the dial.

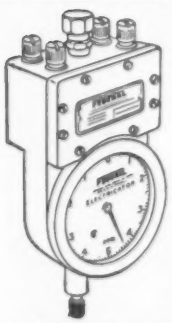
faster gaging . . .

ELECTRIFYING RESULTS . . .

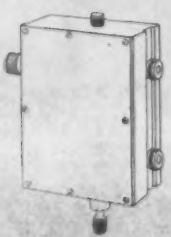
when you use the ELECTRICATOR



WETPROOF STYLE
(For each regular model)



DOUBLE UNIT MODELS
(Four limits, five categories)



ECCENTRICATOR
(For indicating eccentricity, runout, squareness)

There's nothing quite like the Federal Electricator — so easy to apply — so economical — so accurate . . . a Miracle Movement Dial Indicator and two-limit, spindle-actuated switch combined. Use it with tolerance lights in place of your dial indicator for faster, more accurate bench gaging. Use it together with a signal unit for fully automatic inspection or automatic machine or process control.

The Electricator is a high precision unit — switching accuracy is better than 50 millionths on all models. Voltage across the switch is extremely low and switching current is in the order of one milliampere. Therefore, arcing and pitting of contacts is eliminated and accuracy is reliably maintained. The Electricator is calibrated, so it requires only one master.

All Electricator models incorporate the new Federal Miracle Movement which is so wear-resistant . . . so shock resistant . . . you will probably never have to repair or replace it. Six regular models are immediately available from stock. Four different graduations — .0001″, .00025″, .0005″, .001″. Prices from $75.

The switching portion of the Electricator is available as a separate unit to operate tolerance lights and/or provide control limits without indicating actual size.

The Federal Eccentricator, a similar type of high precision unit, indicates eccentricity, runout, squareness, etc., *without* being influenced by normal piece-to-piece variations in size.

For more information, write . . .

FEDERAL PRODUCTS CORP.
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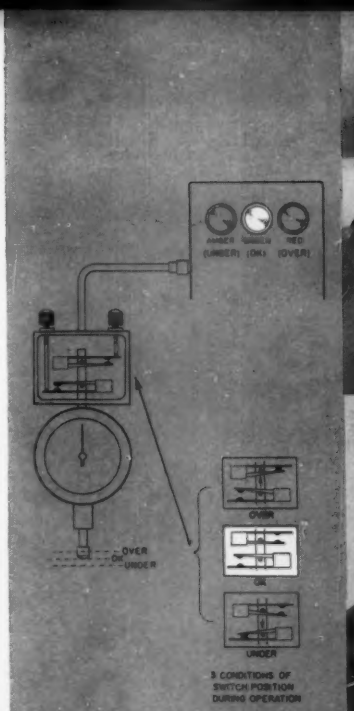
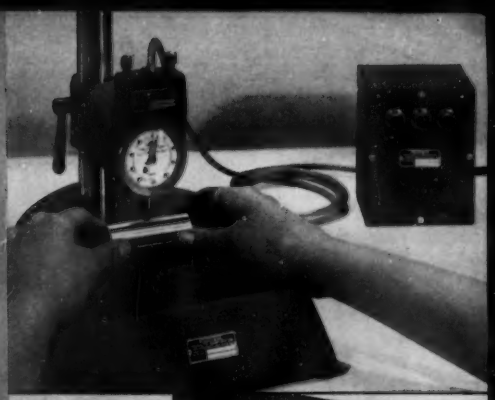
FOR RECOMMENDATIONS IN MODERN GAGES . . .
Dial Indicating, Air, Electric, or Electronic—for Inspecting, Measuring, Sorting, or Automation Gaging

FOR HIGH SPEED BENCH GAGING
(Single or Multiple Dimensions)

It's easy to install the Electricator in place of the dial indicator on your present comparator when you need greater speed. The Electricator eliminates having to make borderline decisions so you get more reliable results . . . and faster results . . . using less skilled help, and with less operator fatigue. Many concerns have up-graded their manual gaging this economical way with great success.

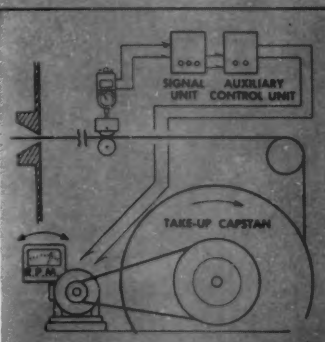
The Electricator offers the most economical way to make multi-dimension checks rapidly and reliably. The signal lights on its control panel instantly show the operator whether the piece is within tolerance or not. No need for operator to look at a group of indicators one by one in order to determine acceptability.

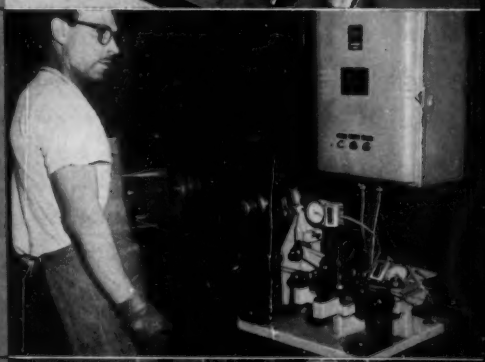




CONTINUOUS PROCESS CONTROL

Because the Electricator is compact, it can be installed easily on most continuous processes to indicate size trend accurately so correction can be made *before* scrap is produced. In many cases, Electricator, working into appropriate signal unit, can be used to *control* size so process automatically produces within tolerance.

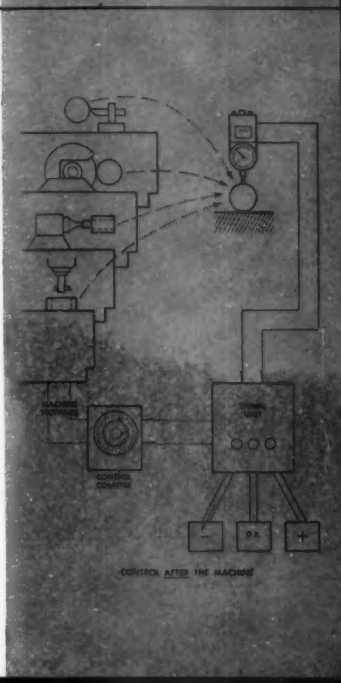


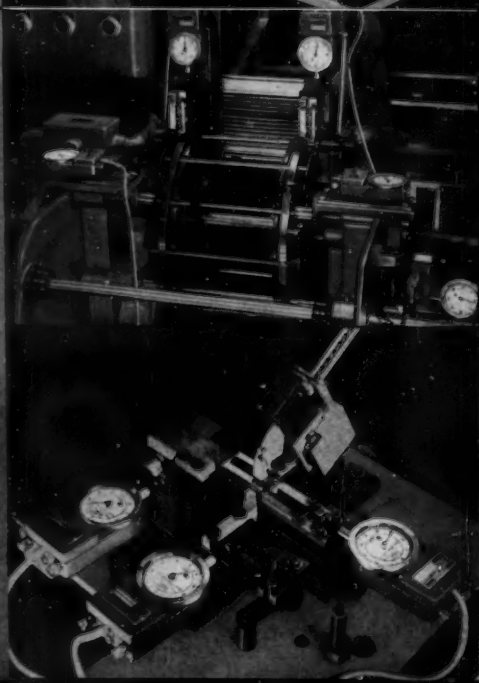


HIGH SPEED AUTOMATIC MULTI-DIMENSION INSPECTION AND MACHINE CONTROL

Electricators have rapid response — can gage and sort up to 6,000 pieces per hour, providing up to 5 sorting categories. Wide range adjustment of limits to suit tolerances. Use of low switching voltage and current provides high-reliability performance.

Electricator can also provide post-process machine control in addition to high-speed gaging and sorting. Using simple control counter, gage automatically stops machine when tolerance limits are exceeded.





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vibration

Finishes parts up to 100 times faster!

New Pangborn Air-Cushioned Vibratory Finishing Machine—culmination of Pangborn's years of experimentation and refinements*—gives tremendous savings in finishing costs!

This is the 6 cu. ft. capacity Pangborn Air-Cushioned Vibratory Finishing Machine . . . perfect solution for cleaning, descaling, deburring, grinding, radiusing, fine-finishing, coloring or burnishing all metal and metal alloy parts, many suitable plastic and ceramic items.

- Works up to 100 times faster than conventional methods at lower cost.
- Most compact vibratory machine on the market.
- Air cushion suspension gives automatic leveling and amplitude control, supplants spring suspension systems subject to fatigue.
- Does work impossible to do by barrel finishing or other means.
- Standard basic machines are equipped with mechanically variable speeds.
- Floor vibration entirely eliminated, making possible (for the first time) second floor mounting.

Available in a wide range of sizes. Also auxiliary equipment, media and compounds for every need. Send parts with exact finish specifications, or finished specimen, for sample processing in our laboratory, to: Mr. William E. Brandt, PANGBORN CORPORATION, 4700 Pangborn Blvd., Hagerstown, Md.

*Pat. No. 2,422,786; June 24, 1947

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Please be specific _____

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For additional tickets, and exposition information write to: National Machine Tool Builders' Association 2139 Wisconsin Ave., Washington 7, D.C.

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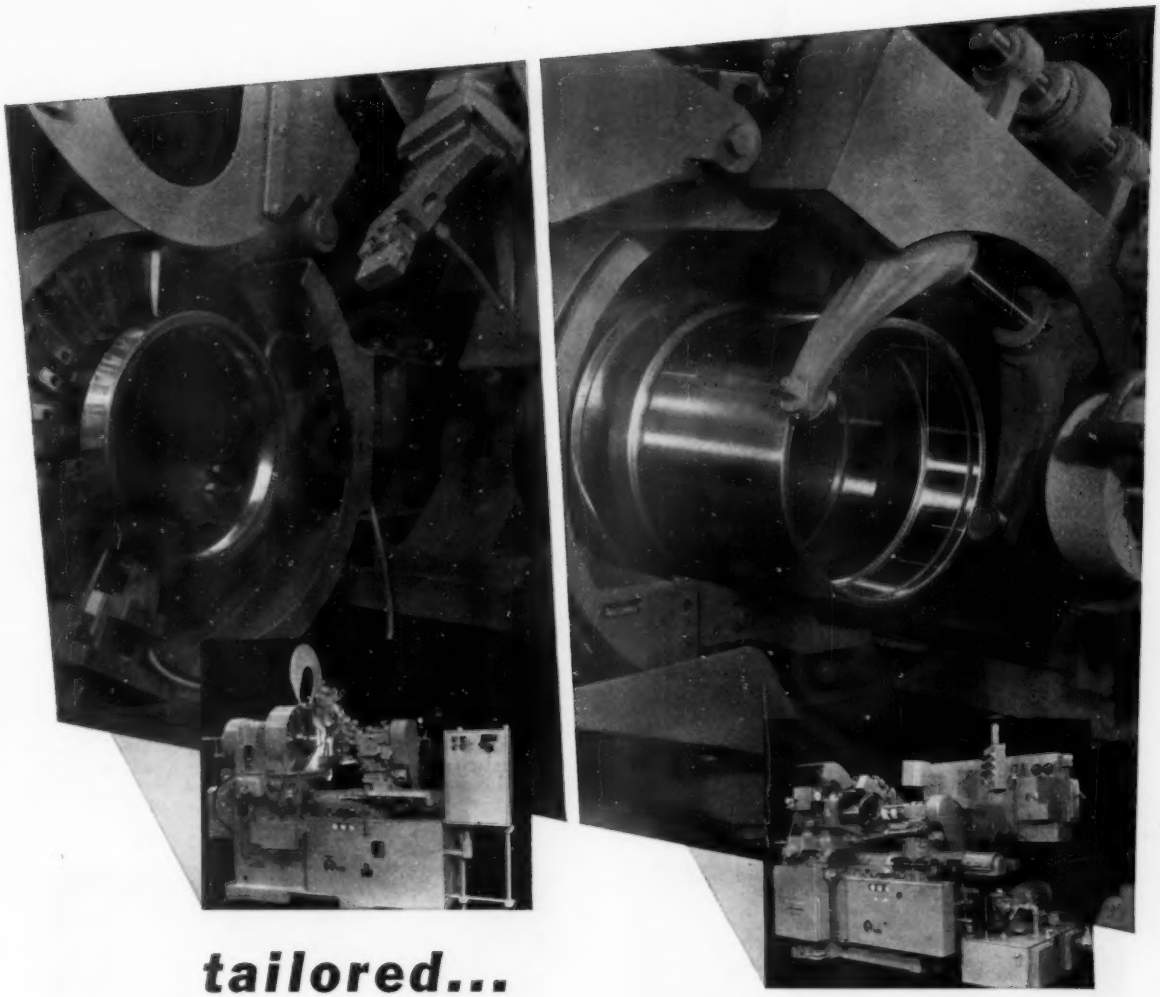

tailored...

For long or short runs on large bearings

Whether you are grinding a range of bearing races involving one shape in various sizes, or parts which involve a complete change in configuration — for example, from roller bearings to ball tracks — the versatility and tailored tooling of Bryant Internal Grinders assure you of record production rates and consistently high quality.

Contact your nearest Bryant or Ex-Cell-O sales representative and let him show you how Bryant Internal Grinders can improve your production of varied workparts.

BRYANT Chucking Grinder Co.

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Precision Internal Grinders, Spindles, Special Machinery and Components

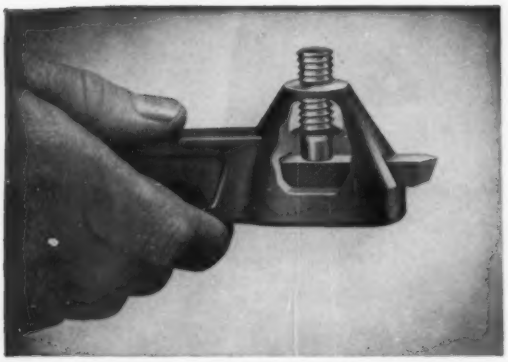
MODERN MACHINE TOOLS MMT=PE PRODUCTION EFFICIENCY

BOOTH NO. 936

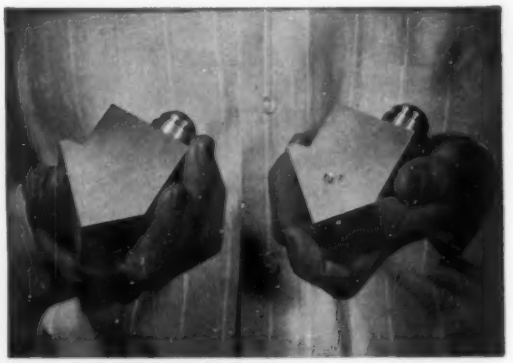
Practical Tooling Tips

NUMBER 1 OF A SERIES

Everyday more and more shops are using standard Vlier Tooling Accessories in place of custom-made devices for both tooling and original equipment applications. The precision construction, product uniformity and quick availability of these simple time-savers have made them tool room favorites. Why don't you start saving from their use?

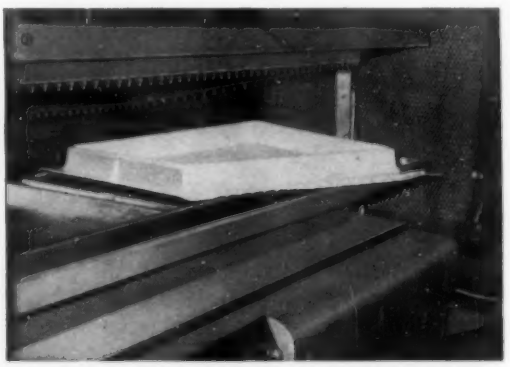


TO GET GREATER TOOL BIT RIGIDITY replace the tool holder screw with a Vlier Swivel-Pad® Clamp. The large, flat pad face provides many times more clamping area. Bits can be held tighter, reducing chatter and vibration. Small, narrow cut-off blades, multipoint tools, even stub ends can be rigidly held. Unique ball joint construction gives smooth angle adjustment in all directions.



EASY WAY TO STOP MARRING surface of part held in fixture. The part on the left was securely held in the fixture with a Vlier Swivel-Pad® Clamp. The scrapped part on the right was held with an ordinary set screw. With the Vlier Swivel-Pad® Clamp the pad stops at first contact with the part; screw torque is absorbed by a ball, preventing damage to the part. This exclusive ball joint construction also provides adjustment to off-angle surfaces.

SPRING PLUNGERS LET WRENCH DO MULTIPLE DUTY—The compression tool shown above is used to attach connectors to electrical wires. Formerly, each size wire connector required a different size tool. But now, through the use of Vlier Spring Plungers, one tool attaches all sizes of connectors—through the use of changeable jaws. The appropriate jaw for any size connector is easily inserted, accurately positioned, and held in place with a Vlier Spring Plunger.



THE RIGHT AMOUNT OF END PRESSURE AND NO MORE is what this spring plunger application calls for. More than 150 Vlier Spring Plungers are used to hold a plastic sheet in position during the forming operation of a plastic refrigerator door liner. Spring Plungers provide just the right amount of pressure to produce a perfect liner.

New catalog now ready!
Send for your copy today.

Insist on Vlier Tooling Specialties...
there's still no substitute for quality.

VLIER ENGINEERING CORPORATION

A subsidiary of Barry Controls, Inc.

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A ROOMFUL of THOMPSON GRINDERS

This is the eighth Thompson grinder recently installed at Jessop which grinds plates and sheets up to 60" × 96" in size.

Jessop precision ground flat stock which is used in gages, dies, verniers and other exacting products.

Pictured above are 4 Thompson Grinders in the Specialties Division of Jessop Steel Company, Washington, Pennsylvania. There are 4 more Thompsons which are not shown in the above photo. All these Thompson machines are grinding to the extremely accurate tolerances and fine RMS finishes that distinguish Jessop's precision ground flat stock.

There are excellent reasons for using 8 Thompsons on this essential production. Mr. Joseph Manfredi, who is responsible for the quality and production of this famous ground flat stock, says, **"We have recently installed our eighth Thompson grinder in this division. We have proven the top performance of these rugged machines for many years. They give us the extreme accuracy and precision we demand—day after day with a minimum of maintenance."**

You may not need 8 Thompson grinders in your operations but it will pay you well to investigate what just one Thompson machine can do toward saving time, improving your products and cutting your costs of manufacture.

Your inquiries are invited.

MMF PE

THE THOMPSON GRINDER CO.
SPRINGFIELD, OHIO

"Keep Thompson in mind for that daily grind"

Thompson SURFACE GRINDERS

What did this failure cost?

LOOK TO INGERSOLL FOR THE ANSWER

Probably a lot more than should have been gambled! Misapply a cutter, or fail to match it to the machine, and costly failure can be predicted as a certainty.

Only when metal removal programs are carefully analyzed in advance can cutter misapplications be assuredly avoided. That's why many firms rely on Ingersoll for help in arriving at the economical answers to their cutter selection and application questions.

Costs reduction is planned before, not after the work is done. Why not let an Ingersoll representative make a preliminary survey of your upcoming metal removal jobs? It will cost you nothing . . . could lead to important savings. Ask a representative to call, or write for the booklet, "Ways to Reduce the Cost of Chips." Address Dept. F-68.

THE **INGERSOLL**
MILLING MACHINE COMPANY **CUTTER DIVISION** ROCKFORD, ILLINOIS

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EXTRA HEADERDIE (type W1-2D)
The fastener industry's first choice die steel

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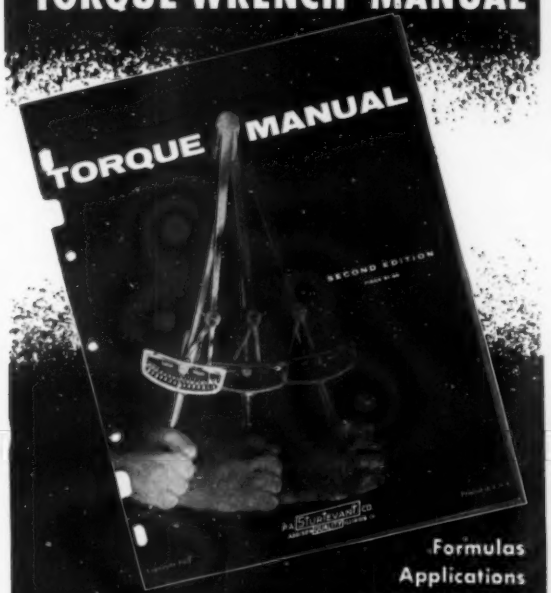
"TORQUE WRENCH" MANUAL



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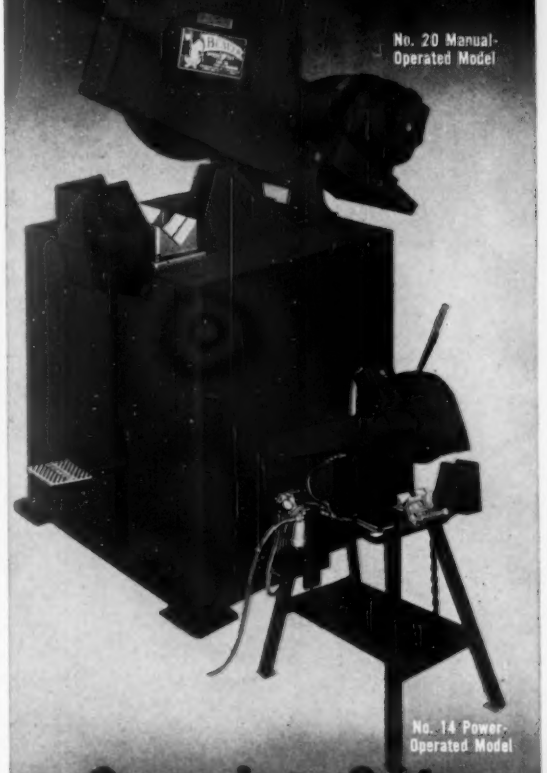
ALMOST ANYTHING IN SECONDS!



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Abrasive Cutting Machines
MANUAL OR POWER-OPERATED MODELS
FOR WET, DRY OR ANY-ANGLE CUTTING!

Speed Cut — *Send for complete catalog and name of nearest distributor*

BEAVER PIPE TOOLS, INC.
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Use Reader Service Card, CIRCLE 96

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to attend these *important* events

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Los Angeles Sports Arena

TOOL SHOW and ENGINEERING CONFERENCE

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New York Coliseum

For further information contact

AMERICAN SOCIETY OF TOOL AND MANUFACTURING ENGINEERS
10700 PURITAN AVE., DETROIT 38, MICHIGAN

Better RED RING tooling
through intensive research

A new COMPUTER (the latest BENDIX Alpha-Numerical type) has enabled us to greatly accelerate our continuing program of basic research in both gear and broaching practice.

Another important advantage of this equipment is utilized in the day to day design of individual shaving cutters and honing tools to meet certain specified operating conditions. With the computer, all of the many design possibilities are rapidly evaluated in order to be sure of the very best selection.

Red Ring engineering know-how plus high-speed electronic calculation is your assurance of the most effective tooling for your own production needs.

SPUR AND HELICAL GEAR SPECIALISTS
ORIGINATORS OF ROTARY SHAVING,
GEAR HONING AND ELLIPTOID

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NATIONAL BROACH & MACHINE CO.

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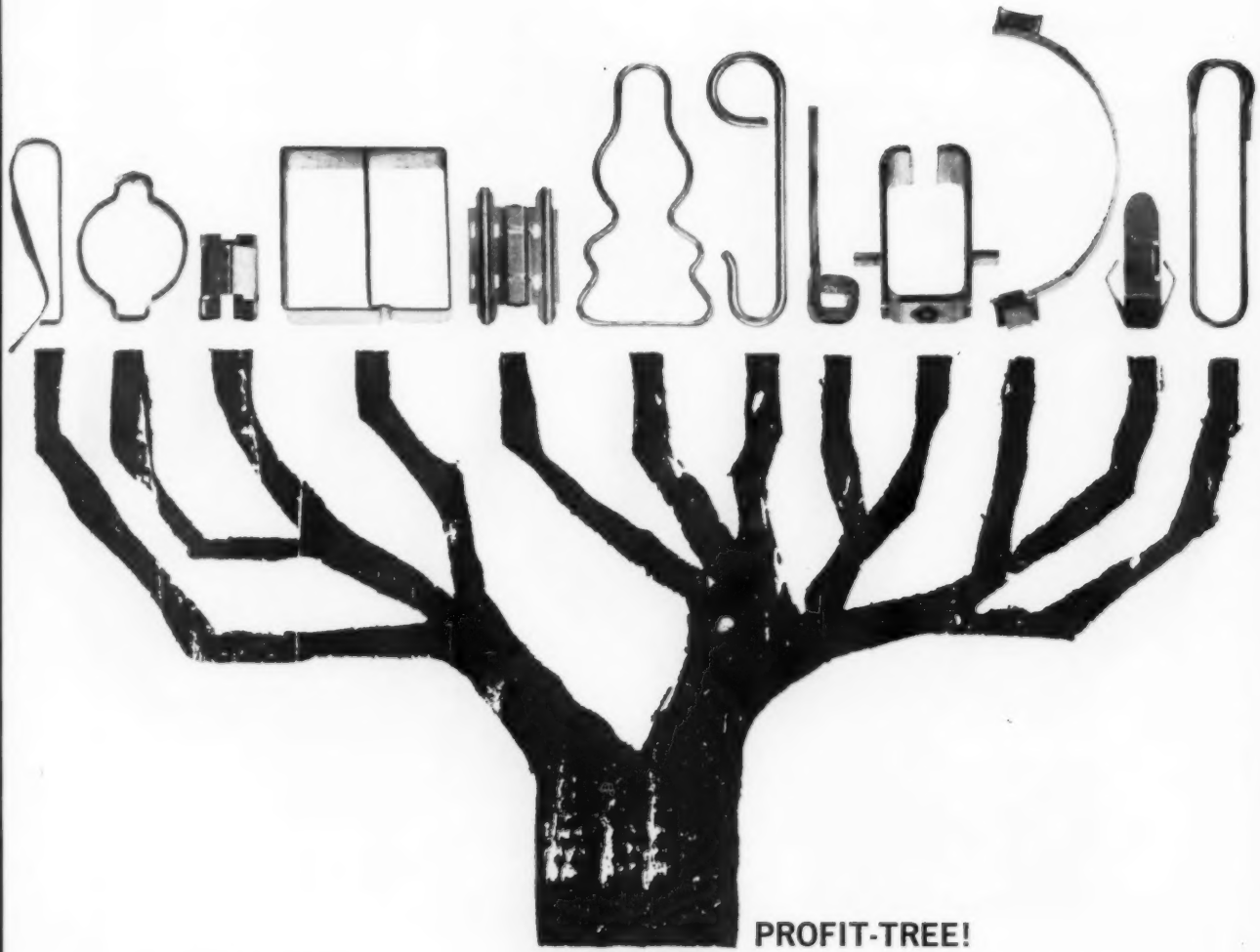
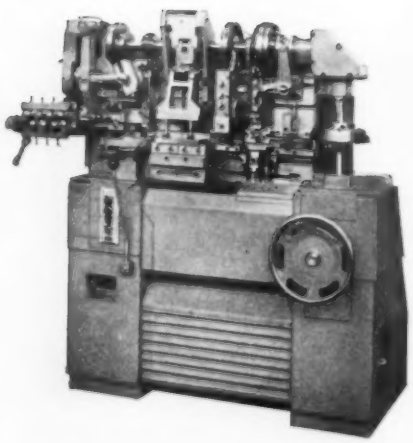
WORLD'S LARGEST PRODUCER OF GEAR SHAVING EQUIPMENT

THESE PARTS ARE BEING PRODUCED AT SPEEDS OF 90 TO 250 PCS/MIN



PROFIT-TREE!



These are formed parts produced in single automatic operations on the revolutionary new Torrington Vertical 4-Slide.

With precision and speed, the Verti-Slide has replaced as many as five and six progressively tooled presses in the production of a complex part. Normal secondary operations such as welding are being done in one continuous automatic operation in excess of 100 pcs/min.

If you make or buy complex wire or strip parts, the Verti-Slide method offers dramatic reductions in production cost. Less parts handling, in process inventory, machine space—all mean greater profits to you.

Write or call for field technical data or a Torrington Sales Engineer.

THE TORRINGTON MANUFACTURING COMPANY

MACHINE DIVISION Torrington, Connecticut

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Proper tooling solves time, torsion, and thrust problems. Solving these three problems, Michigan engineers properly adapt modern cutting tools to this double-end turret machine and complete its design for profitable operation. Gas meter bodies are drilled, reamed, tapped, bored, chamfered, and spot-faced at a rate of ten per hour. You can imagine the value of the piecepart at this point, and how inefficient tool changing could cost thousands of dollars per year. That's why tool change *time* is controlled by presetting drills outside the machine in Scully-Jones "Stub-A-Long" chucks. The same chucks solve another problem — *torsion.* Long drills are like torsion springs, and torsional twist or vibration on the cutting edges is proportional to projection. Stubbing

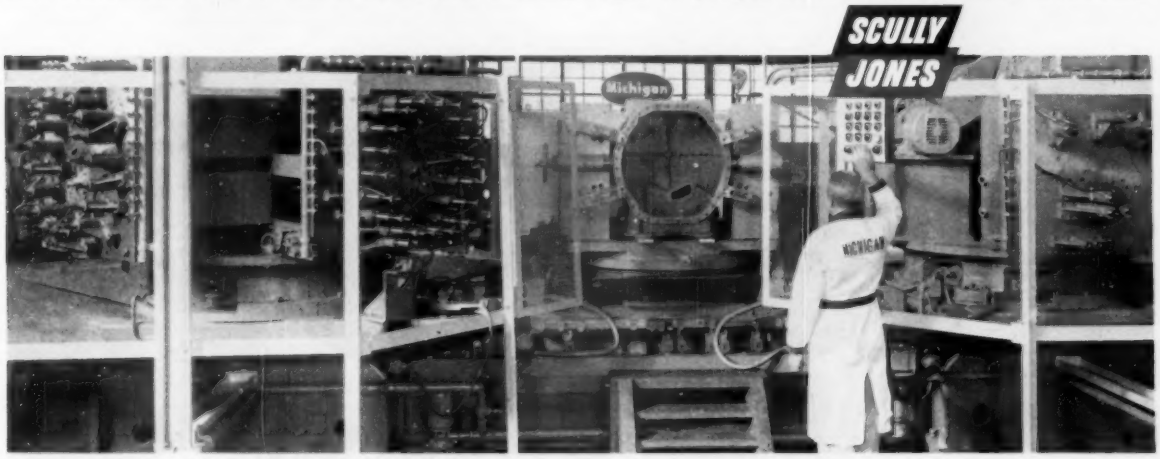

Photo: Courtesy, Michigan Special Machine Company

drills in holders makes them stiffer — reduces chatter and saves drill life. The third problem, *thrust*, is solved by Scully-Jones compression-type tap holders. They compensate for any variation between feed or thrust of spindles and lead of taps. Spring lets tap follow own lead, prevents breakage where previous drilling operations fail to provide hole for tap, and cushions shock to tap and spindle, especially when reversing. These holders also are preset outside the machine. Fast depth adjustments are made by the Quick-Lock nut, which clamps anyplace on the threaded shank of the holder. Your Scully-Jones representative or distributor can show you a complete line of tools that eliminate 80% of tool-change downtime on multiple-spindle machines.

Scully-Jones and Company 1915 South Rockwell Street, Chicago 8, Illinois

No Grinding... No Blade Resetting

NEW KENDEX* MILLING CUTTER USES THROW-AWAY INSERTS

With a heavy cutter body . . . and more than 5/8-inch of solid Kennametal* backing up each insert . . . new Kendex Milling Cutters are built for the rugged service necessary for fast metal removal. The one-piece cutter body is made of heat treated steel. A 15-degree corner angle minimizes pressure on the workpiece. Solid Kennametal wedges and seats provide close-tolerance, positive positioning of the insert . . . to permit maximum utilization of available power.

Get more information. For dimensional specifications and prices, ask your Kennametal Representative, or write for Supplement No. 9A to our Metalworking Catalog. KENNAMETAL INC., Latrobe, Pa.

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33512

INDUSTRY AND
KENNAMETAL
...Partners in Progress

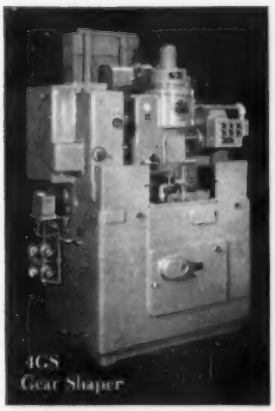
Each 3/4-inch square Kennametal insert provides eight separate cutting edges. When one edge becomes dull, the clamp is released and the insert given a quarter turn to a new, sharp edge. It is then reclamped, without need to reset or gage the tool. When all eight edges (four on each side) have been used, the insert is replaced by a new one.

Retracting the wedge, by means of a double-end screw, quickly releases the inserts. *Held in by the screw, the wedge cannot fall out*, regardless of the cutter body position.

INVOLUTE GEARS

NON-INVOLUTE PARTS

FELLOWS GEAR SHAPERS DO DOUBLE DUTY



4GS Gear Shaper

Fellows Gear Shapers are not limited to the production of gears alone. They are valuable production machines ideal for the manufacture of many types of parts, of both involute and non-involute form.

As gear shapers, they provide high production rates in the manufacture of internal and external spur and helical gears. As general purpose production machines, they also make possible the economical production of irregularly shaped parts . . . in many cases doing in one simple operation what would require several operations using conventional shop tools.

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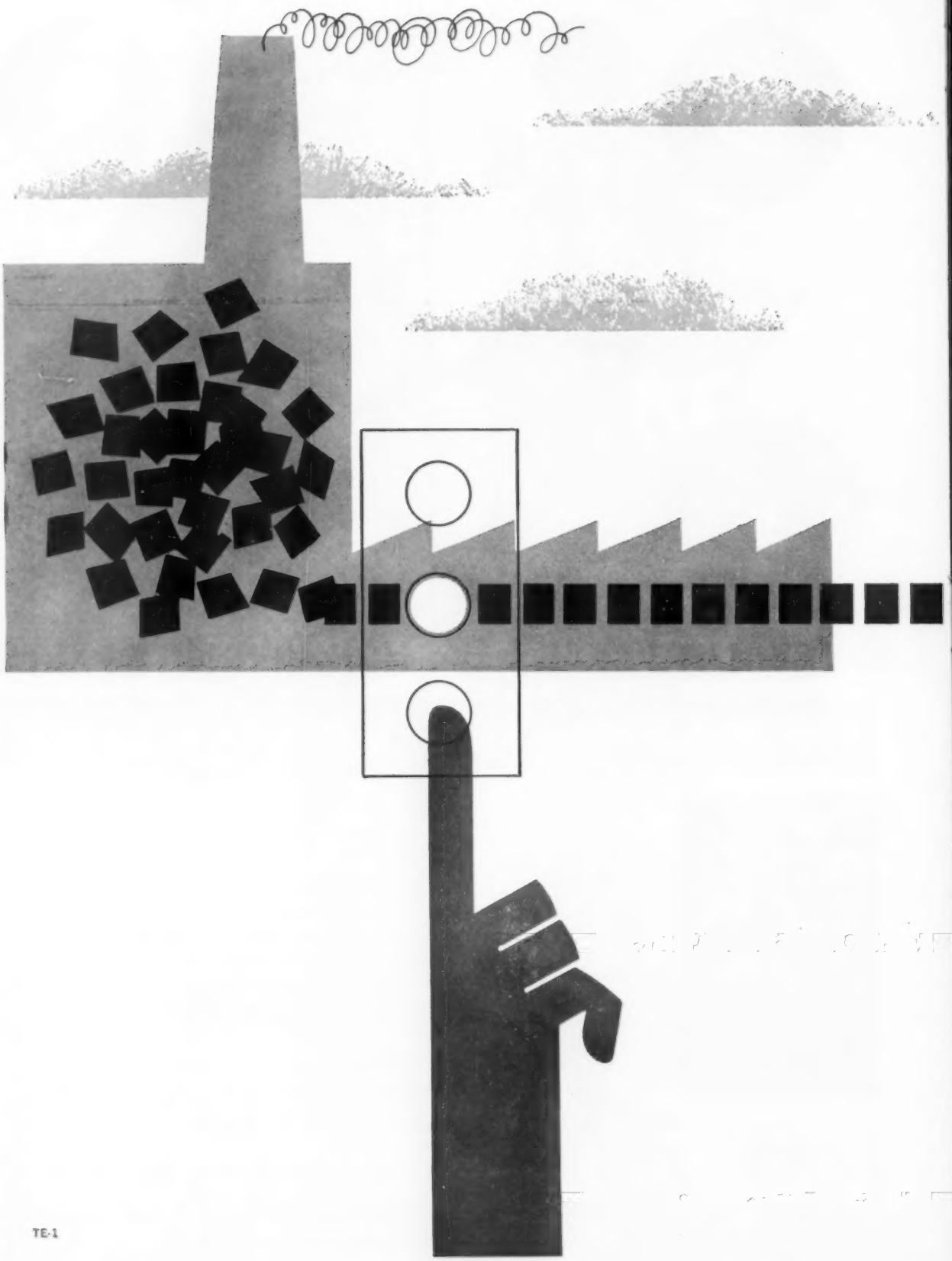
THE PRECISION LINE

Fellows

Gear Production Equipment



TE-1

Are you working toward automatic machine tool control?

The means by which instructions are reduced to the language of machinery and conveyed as intelligible orders to that machinery comprises the system complex which makes automatic control possible.

For many years North Electric has been designing, engineering and manufacturing such system complexes, over 5,000 of which are in operation today!

The selection and application of components, a thorough understanding of advanced switching techniques and complete familiarity with complex circuitry design are but three of the many highly specialized areas demanding unique capabilities and which are frought with danger for the uninitiated. This is the professional climate in which the experienced, system-concept-minded engineering group at North Electric works constantly and continuously!

If you are working toward automatic control of machine tools and automation of production machinery, you cannot help but profit when you call on the most experienced system group available.

If these are your goals—you'll want NORTH on your team. Write, wire or phone for an appointment to learn how much North can do for you.

ELECTRONETICS DIVISION

NORTH ELECTRIC COMPANY

GALION, OHIO

HOGGSON BRAND

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rounded face
steel
stamps

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Order from this handy chart:	
Gothic style	*size (inches)*
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A	5/32
A	3/16
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On all the new lightweight metals HOGGSON BRAND Les-Strain steel stamps are the safest means of permanent identification . . . .

fracture is held to an absolute minimum

rounded faces of the character indent, but do not cut or crack the metal under normal use

HOGGSON BRAND Les-Strain stamps are:

manufactured of high strength alloy steel

designed with chamfered front edges to assure correct position for marking

available from stock in sizes shown, in sets of 27 letters and 9 numerals, packed in sturdy wood compartment boxes.

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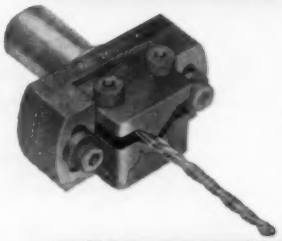

Accurate, rapid set-ups the first time, every time . . . is the reason Brookfield Tool Holders are now widely used in practically every metalworking plant in the country. With one Brookfield Tool Holder, you can cut your stock of bushings by at least 100. Here's why:

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ADJUSTABLE V JAW holds wide range of tool diameters without bushings or accessories.

AXIALLY TRUE DESIGN makes perfect tool alignment almost automatic.

BALANCED-PRESSURE LOCKING ASSEMBLY maintains uniform seating, eliminates creep or shift.

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AVAILABLE IN A WIDE RANGE OF SIZES

MODEL NO.	HOLDING RANGE	SHANK DIA.
BA-10	1/64"–3/16"	5/8"
DA-10	3/64"–1/2"	3/4"
DA-12	3/64"–1/2"	3/4"
GA-12	1/16"–3/4"	3/4"
GA-16	1/16"–3/4"	1"
KA-16	1/16"–1"	1"
KA-24	3/16"–1"	1 1/2"
PA-24	1/16"–1 1/2"	1 1/2"
PA-28	1/16"–1 1/2"	1 3/4"

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- Best possible delivery.
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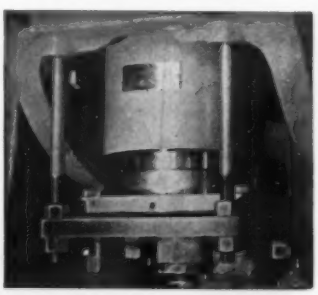

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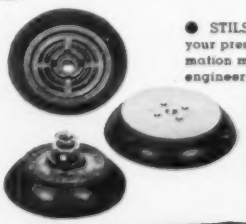
. . . adapt present air compressor equipment to vacuum pick up. They are small, compact, efficient and quiet.



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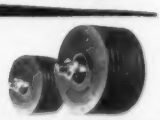

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Concentricity of Ball & Shank Plus or Minus .0002

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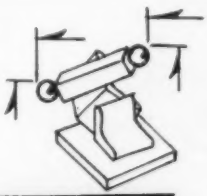
Two Styles 3 Shank Diams. each.



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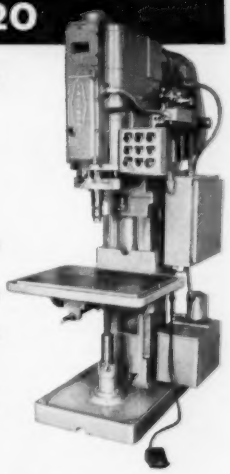
FOR HIGH SPEED PRECISION TAPPING CHOOSE THE

kaufman

MODEL 10E-20



Six features of this new, precision-built Kaufman Tapping Machine are:

1. Lead screw control for accurate threads and maximum tool life. Maximum 4½" lead screw travel.
2. Rapid approach of spindles to work.
3. Clutch operated for faster operation — Reversing spindles at twice forward speed.
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5. Units provided with 5-7½-10 H.P. Motors.
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KAUFMAN

For additional information about the new Model 10E-20 or other Kaufman machines for single or multiple operation, write or telephone:

KAUFMAN MFG. CO.

553 S. 29th Street Manitowoc, Wisconsin

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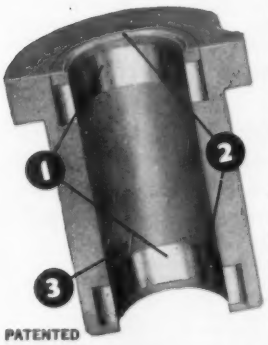
Does the job of Solid Carbide and MEYCO COSTS LESS!



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1. Tungsten carbide rings at the points of wear; 2. Steel rings protect drills and carbide; 3. Special hardened alloy steel body.

There in a nut shell is the story of MEYCO carbide inserted drill jig bushings! Does everything a solid carbide bushing will do at less cost: lasts almost as long; increases life of drills and jigs; greater accuracy—longer; saves man-hours and machine down-time! All this spells high production at a lower cost. For over a decade, carbide inserted drill jig bushings have been saving money on long production runs for cost conscious customers.

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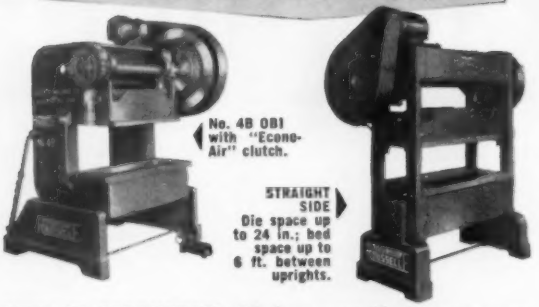
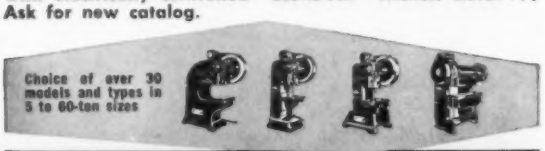


SPEED UP PRODUCTION with these versatile 40-ton presses. Large bed and ram areas make them ideally suited to handle wide rolls or sheets . . . do multiple punching, steel-rule die work and other high output operations. For rapid shockless starting and stopping, presses can be equipped with electrically controlled "Econo-Air" friction clutch . . . Ask for new catalog.



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Rousselle Presses are sold exclusively through Leading Machinery Dealers.

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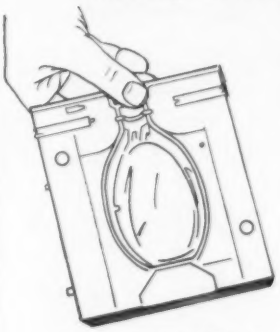

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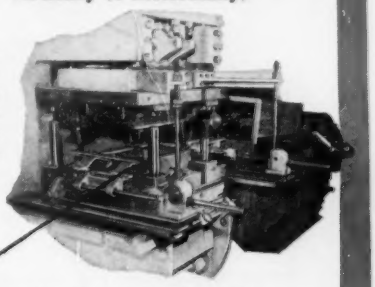
Die changeover is quickly made. Economical even for low volume production on new or existing equipment.



Press application of small 3-station line transfer unit shown.

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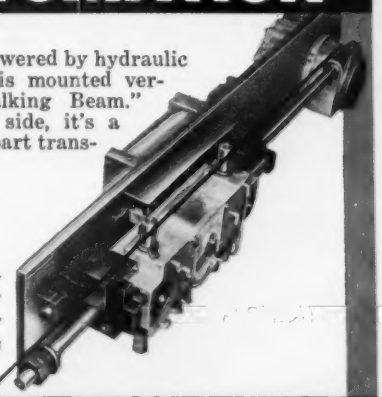

There is a LIVERNOIS *Transfer Unit available for most applications*

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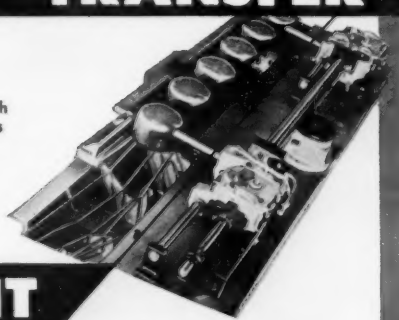
Patented—with other Patents Pending



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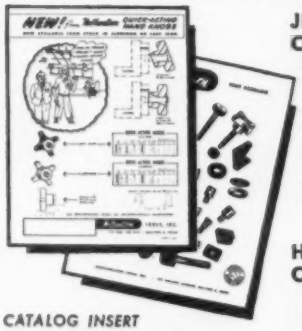

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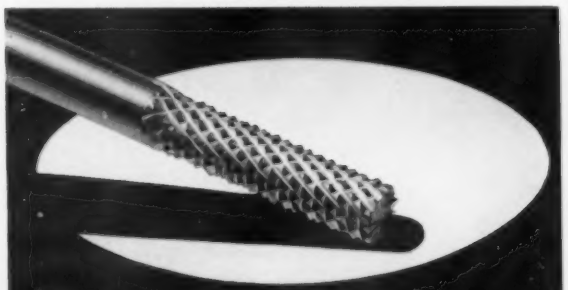

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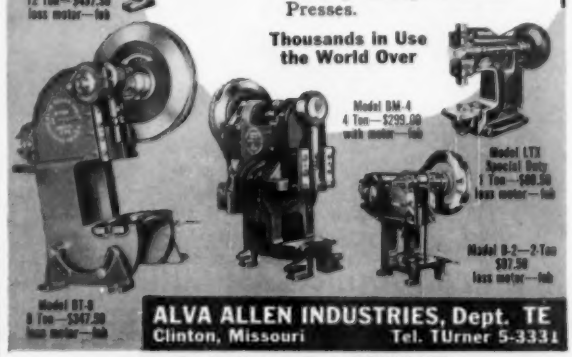

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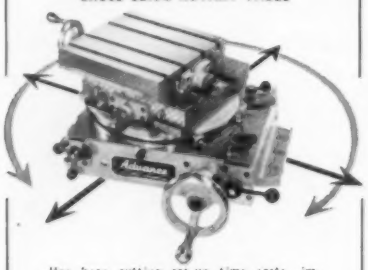

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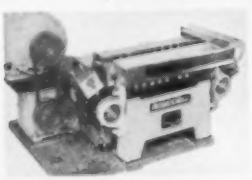

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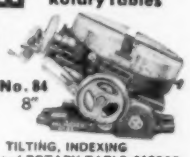

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July 1960

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LOOKING AHEAD

By T. W. Black
Senior Associate Editor

Some new developments in materials: Metals reinforced with ceramic fibers may be used in tomorrow's hypersonic aircraft, missiles and spacecraft. Tensile strengths as high as 3 million psi are possible with some of the ceramic fibers now available. These fibers can be incorporated in a metal matrix, giving much higher strength than is possible using the metal alone.

A material now under development by Horizons, Inc., uses aluminum oxide fibers in sapphire or corundum single-crystal form. The matrix is 80 percent nickel, 20 percent chromium. About half of the fiber's tensile strength is retained at the melting point of the nickel-chrome alloy.

Corning Glass Works has developed two ceramic powders that can be formed into shapes used in hot tooling. First applications will be for tools, jigs and fixtures in the aircraft and missile industry, where shaping of exotic metals requires great heat and pressure.

One of these materials, Corcast, is formed by casting. Service temperature is 2500 F and the coefficient of thermal expansion is practically zero. Compressive strength is 2000 to 3000 psi.

Another high-temperature material, pyrolitic graphite is being produced in large pieces by the General Electric research laboratory. This material has a tensile strength of approximately 40,000 psi at 5000 F, compared to 1000 psi for tungsten, the best high-strength material now known. One possible industrial application is as a surface material for hot-pressing dies.

General Electric has also announced the development of a solid lubricant with as much as 20 times the load-bearing capacity of conventional lubricants. The improved lubricant was achieved by the addition of various inorganic sulfides to molybdenum disulfide. The lubricant is especially suitable for high-temperature applications.

Annealing operations have long been a bottleneck in the production of strip and sheet products of steel, brass, copper, aluminum and other metals. Direct induction is used in a continuous annealing process developed by the Penn Induction Corp. and Pennsylvania Electric Coil Corp. The metal heats itself much like an electric toaster element. Grain sizes are 1/3 to 1/5 those produced by the usual annealing methods.

Ford Motor Co. has upped the production of open-hearth furnaces about 300 percent by the use of oxygen jets and the substitution of burned lime for limestone. This hastens the chemical and thermal reactions that convert the ingredients into molten steel.

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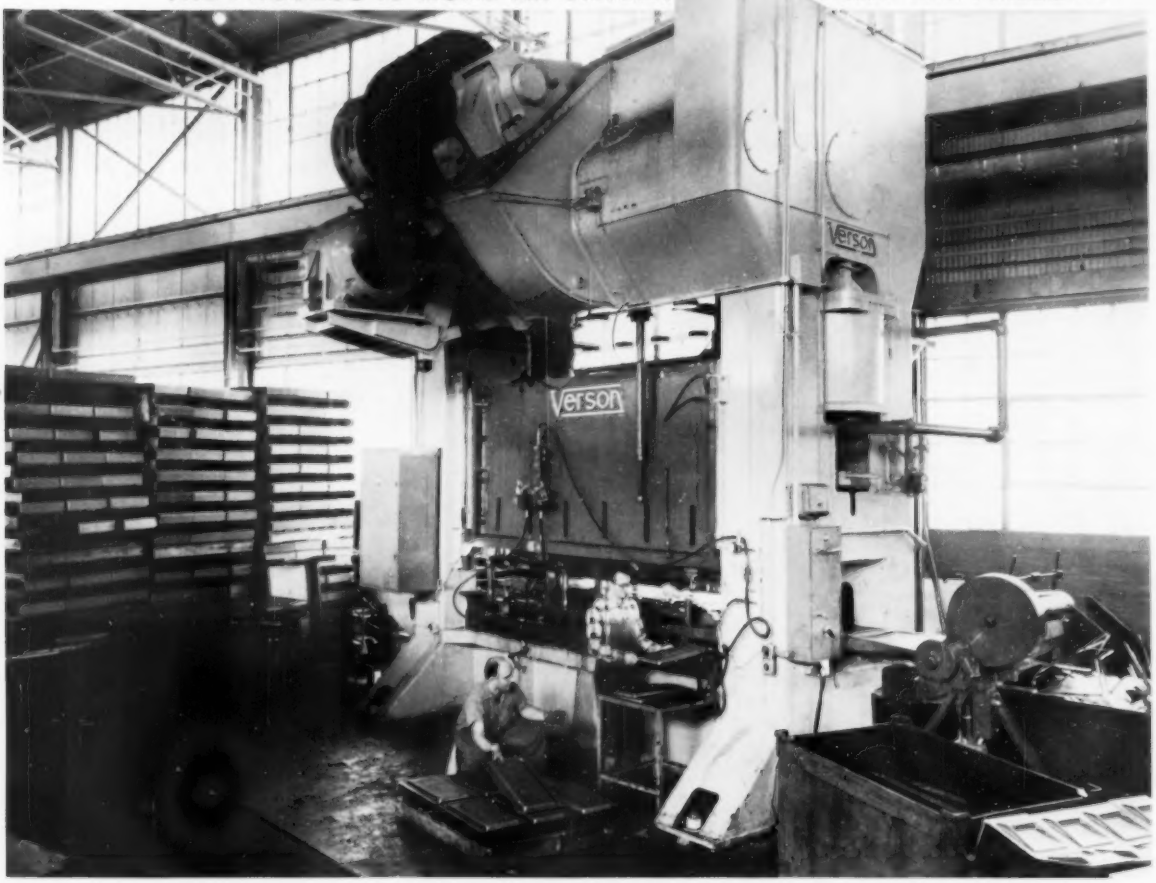

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